Underutilized housing in an aging society: How bequest motives impact housing choices[†]

December 31, 2022

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Abstract

The housing stock can be underutilized if a household maintains a large housing capacity. This study sheds light on elderly households' underutilization of housing by focusing on how a bequest motive plays a role. Japanese household data show that underutilized rooms are more pronounced for non-moving elderly households that recently renovated their houses. We find that the motive to bequeath housing causes housing underutilization through less mobility and more renovations, even for working-age households. The underutilization of housing by elderly households implies the inefficient allocation of productive resources in an aging society, exacerbating a housing affordability issue.

Keywords: underutilized housing stock, tax distortions, mobility, renovation, aging society, IV probit model, Japan, 3SLS
JEL: J14, H21, R21

[†] We thank Norifumi Yukutake, Tsunao Okumura, Yasushi Asami, Masashi Takahashi, Anil Kumar, Hitoe Ueyama, Michio Naoi, Abdullah Yavas, Iichiro Uesugi, Brent Ambrose,Takuya Ishino, Charles Ka Yui Leung and seminar participants at the University of Tokyo, the Research Institute for Capital Formation, Toyo University, Penn State, Keio University, Homer Hoyt Weimer School, and Baruch College, and participants at the 15th Western Economic Association International Conference, the Applied Regional Science Conference, the Asian Real Estate Society Meeting, the Japanese Economic Association 2019 Fall Meeting, and 2020 ASSA meeting for valuable comments and suggestions. The data for this analysis, Japan Household Panel Survey (JHPS/KHPS), was provided by the Keio University Panel Data Research Center. This work was supported by JSPS KAKENHI (Grant #JP17H00988 and #JP22H00065).

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1 Introduction

The accumulated housing stock may not be allocated efficiently to those who can make the best use of it. A well-documented inefficiency is vacant houses. Housing vacancy rates are 13.6% in Japan and 11.1% in the US, according to the OECD Affordable Housing Database.[1] However, an often overlooked inefficiency is the underutilization of occupied housing stock. In an aging society, an increasing fraction of households has become "empty nests" after children leave their houses. Standard life-cycle and housing-choice models suggest these households extract home equity to support consumption by downsizing a house (e.g., Artle and Varaiya, 1978; Yang, 2009; Bajari et al., 2013; Bayer et al., 2016; Nakajima and Telyukova, 2017). However, many households continue to live in their original houses by keeping rooms underutilized (Venti and Wise, 1989, 2004).[2]

Figure 1 depicts the average number of rooms per household member compiled by the OECD. The number for outright owners is 3.8 in the US and 2.6 in Japan. These housing capacity statistics imply that the household with an average family size owns 9.5 rooms in the US (for 2.5 members) and 6.0 rooms in Japan (for 2.3 members).[3]

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[1] https://www.oecd.org/housing/data/affordable-housing-database/housing-market.htm

[2] Cocco(2020) analyzed retirees' consumption and homeowership decisions that invorporates aging in place utility benefis and housing maintenance choice.

[3] A room does not include a bathroom but includes kitchens in the Japan Household Panel Survey, the US-ACS, CASEN, ENIGH and KHS and kitchen-cum-dining rooms in EU-SILC and GSOEP. A room mus be greater than four square meters in EU-SILC and six square meters in GSOEP, and must extend out at least 6 inches and go from floor to ceiling in the US-ACS.

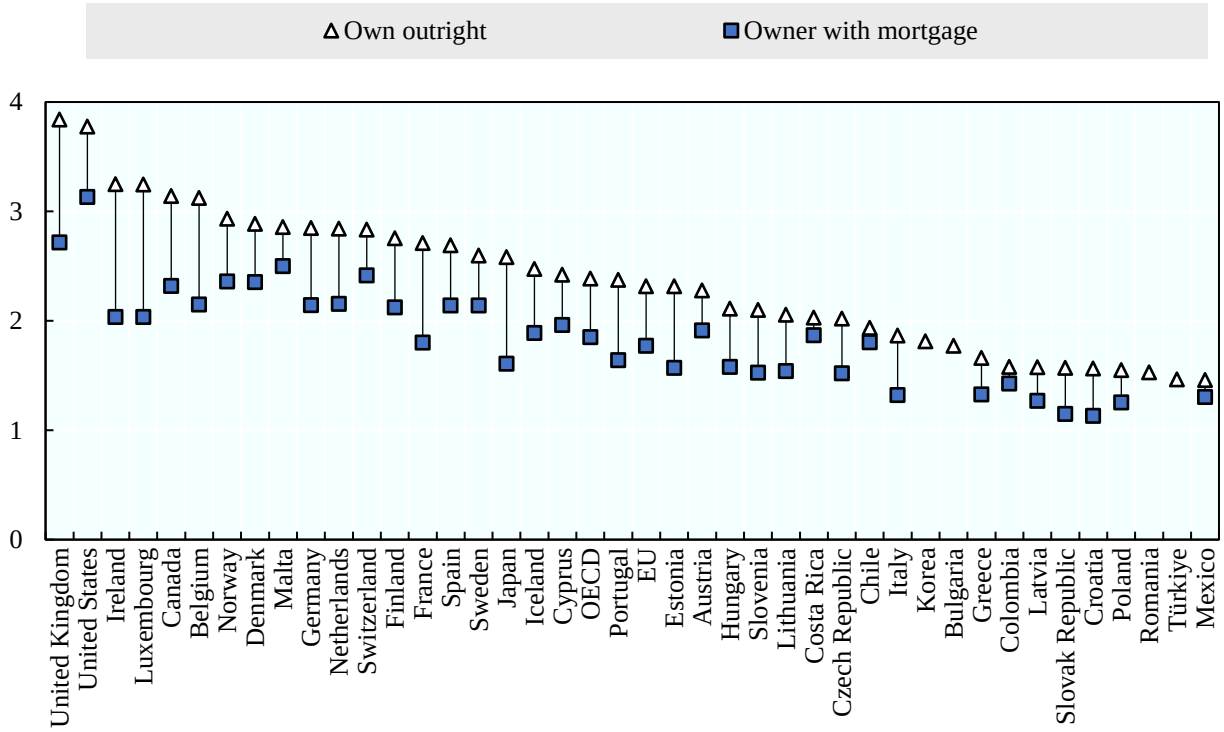

Figure 1 Average Number of Rooms per Household Member

Note: The source is the OECD Affordable Housing Database HC2.1.1. OECD calculations based on European Union Statistics on Income and Living Conditions (EU SILC 2020) survey for European countries except for Italy 2019 and Iceland 2018; calculations from Statistics Canada based on the 2016 Canada Census of Population for Canada; Encuesta de Caracterización Socioeconómica Nacional (CASEN 2013) for Chile; the Gran Encuesta Integrade de Hogares (GEIH 2020) for Colombia ; the Encuesta Nacional de Hogares (ENAHO 2020) for Costa Rica ; the German Socioeconomic Panel (GSOEP 2014) for Germany; the Korean Housing Survey 2020; the Japan Household Panel Study (JHPS 2020) for Japan; Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH 2020) for Mexico; Türkiye-National SILC (2020); Understanding Society - The UK Household Longitudinal Study 2020; American Community Survey (ACS 2020) for the United States.

Part of these rooms may be held for reasons. For example, a family theater, gym, and spaces for family gatherings may provide significant marginal utility. Attachment to a house can also be a reason for maintaining a large house. Alternatively, a household may temporarily hold unused rooms because of a real option to accommodate children's coresidence needs. Parents may also view housing wealth as insurance against uncertain financial needs and rental costs (Skinner, 1996; Davidoff, 2010; Lockwood, 2018; Sinai and Souleles, 2001). However, some of the unused rooms can simply be the underutilization of housing stock. Underutilized housing stock will cause an inefficient resource allocation. While the elderly hold excess capacity, the young face an

affordability issue. Also, more productive resources need to be allocated to the construction sector than in the case of no housing underutilization.

This study sheds light on the cause of housing underutilization by using data for Japan, which leads other countries in aging. Japan has the lowest potential support ratio (Age 25-64 / Age 65+) of 1.8 (United Nations, 2019). We hypothesize that the motive to bequeath real estate, which is influenced by inheritance tax, impacts a housing capacity choice. Japanese inheritance and property tax codes significantly favor owned houses over other assets. Thus, a household tends to bequeath real estate instead of liquidated financial assets to avoid real estate transaction costs and inheritance taxes on financial assets.

A real estate bequest motive can affect the utilization of housing through several channels. For example, when a person intends to bequeath a house, the person may continue living in it instead of selling it for profit, even if the house is undesirable. We call this channel the mobility channel. Another channel is the renovation channel. A person with a bequest motive may renovate the house to increase its economic life span or increase capacity to accommodate a coliving child.

Extant studies show that taxes influence bequest motives (e.g., Page, 2003; Joulfaian, 2005; Piketty and Saez, 2013; Stark and Nicinska, 2015; DeBoer and Hoang, 2017), and bequest motives influence consumption and savings (e.g., Abel, 1985; Hurd, 1989; Bernheim, 1991; Kotlikoff and Summers, 1981; Bernheim, 1991; Kopczuk, 2007; Kopczuk and Lupton, 2007). However, whether bequest motives impact the elderly's mobility and renovation is an important empirical question (Venti and Wise, 1989).

We use the Japanese Household Panel Survey (JHPS/KHPS) and define two measures of housing underutilization. The first measure is the number of bedrooms that exceeds the number of household members. We call it excess rooms and calculate for all households. Although some of the excess rooms are purposefully maintained, the number of excess rooms is a proxy for underutilization. The second measure is the number of excess rooms for non-movers that exceeds the number of excess rooms for comparable recent movers. The rationale behind this measure is the assumption that recent movers should have dynamically optimized their housing capacity choice and should have no underutilized room. We call this measure the number of underutilized rooms and calculate for non-mover households. The number of underutilized rooms is zero between 35 and 44 years old but increases with age and exceeds two rooms for 65 years and older.

Our main goal is to test whether real estate bequest motives cause housing underutilization. We also test whether our hypothesized action channels (mobility and renovation channels) are statistically significant. We construct the variable for a real estate bequest motive from the survey questions in the JHPS/KHPS. However, an empirical challenge is endogeneity. For example, a household that had an opportunity to own a large house for a low cost may consider bequeathing it (reverse causality). Alternatively, there may be confounders; for example, a household that anticipates living with a child's household may maintain unused rooms and desire to bequeath the house.

We address these empirical challenges by using a rich set of control variables and a set of instrumental variables. The control variables include housing characteristics, household head characteristics, and children's characteristics. For the instrument, we exploit the 2015 change in the inheritance tax code as an exogenous shock to household decisions. The Japanese inheritance

tax code favors housing by reducing the assessed house value by 80% up to a certain size limit. This tax change increased the threshold lot size from 240 m^2 to 330 m^2, which impacts the intention to bequeath a house. This change does not directly impact mobility, renovation, or housing underutilization because this threshold lot size is relevant only for inheritance taxes. Thus, we instrument the intention to bequeath housing by a set of variables representing this change in the threshold lot size.

Our findings are summarized as follows. First, a real estate bequest motive increases the number of excess rooms and underutilized rooms. A one-percentage-point larger probability of having a bequest motive is associated with 0.077 more excess rooms and 0.072 more underutilized rooms. Second, the effect of bequest motives on underutilization is larger for elderly households and in large metropolitan areas but statistically significant also for working-age households and non-metropolitan areas. Third, the mobility channel is statistically significant. A one-percentage-point larger probability of real estate bequest motive decreases the moving probability by 0.093 percentage points and thereby increases the number of excess rooms by 0.097. Fourth, the renovation channel is also statistically significant. A one-percentage-point larger probability of real estate bequest motive increases the renovation probability by 0.079 percentage points and thereby increases the number of excess rooms by 0.063. Fifth, a real estate bequest motive has a particularly large effect on capacity-increasing renovation. Sixth, a larger number of excess rooms is associated with less perceived happiness, not more.

This study makes four contributions to the literature. First, this is the first study, to the best of our knowledge, to point out the inefficiency of bequest-motivated underutilization of housing stock. This inefficiency issue will become more prevalent in other developed countries as the average

potential support ratio will decrease to the current Japanese level by 2045. Although a growing number of studies incorporate bequest motives and housing in the life-cycle model, they are not concerned about how housing capital is utilized because their objective is to incorporate housing values to resolve the retirement savings puzzle (e.g., Nakajima and Telyukova, 2017). The inefficient use of capital undermines welfare and economic growth because intergenerational transfers significantly contribute to the capital formation (Kotlikoff and Summers, 1981; Barrett et al., 2015).

Second, this study identifies a new kind of tax distortion. This study demonstrates the unintended inefficiencies in housing-capital utilization due to the preferential treatment of housing in the inheritance tax system. Furthermore, our finding that an inheritance-tax change has a significant impact on bequest motives is evidence of a significant elasticity of bequest motives with respect to inheritance tax. This finding serves as an important building block for the discussion of the optimal inheritance tax (e.g., Piketty and Saez, 2013).

Third, this study expands our understanding of housing vacancy. Housing vacancies are predominantly defined by the difference between the number of housing units and the number of households. Unused rooms in occupied housing units are usually omitted, although this type of vacancy is commonly used for commercial real estate, such as offices and warehouses. Adding unused rooms in occupied housing to housing vacancy statistics will significantly increase vacancy rates in many countries.

Fourth, this is one of a small number of studies on parental housing choices regarding mobility and renovations (e.g., Painter and Lee, 2009; Lee and Painter, 2014). Parental housing choices have been studied less than inheriting heirs' housing choices because the proportion of the elderly

was small. However, as many developed countries age quickly, parental housing choices will have first-order importance. For example, the ratio of the working-age population peaked in 1992 in Japan, in 2008 in the US and Europe, and in 2010 in China (United Nations, 2019).

The rest of this paper is organized as follows. Section 2 describes the data set and variables used in the analysis. Section 3 shows the overall effect of bequest motives on housing underutilization. Section 4 shows the effects through two action channels. Section 5 shows the relationship between housing underutilization and perceived happiness. Section 6 concludes the paper.

2 Data

We use Japan Household Panel Survey (JHPS) and Keio Household Panel Survey (KHPS), which are jointly conducted. The KHPS began in 2004 surveying 4005 households, whereas JHPS began in 2009 surveying 4,022 households without an overlap. In both surveys, households are selected through stratified two-stage sampling. The demographic characteristics of the survey respondents are reasonably representative of Japanese households, except that the subjects are of ages between 20 to 69 for KHPS and 20 or above for JHPS. These two surveys were integrated in 2014 into the new Japan Household Panel Survey (JHPS/KHPS).[4]

We use data on households from the JHPS/KHPS between 2004 and 2018. We exclude the self-employed because their bequest motives can be driven by business strategy and alternative tax codes. Regarding housing decisions, we use residential mobility and renovation of current housing.

[4] See Seko, Sumita, and Naoi (2012) for more detailed explanation of the survey.

A dummy variable for a residential move takes one if the household moved its housing and takes zero otherwise. A renovation dummy variable takes a value of one if the household has experienced a change in its housing without changing the address of its housing.

Household attributes include the household head's age, income, financial wealth, housing wealth, household size, and the number of children. They also include indicators for whether a household head is married, employed, and has a college degree. Location characteristics include indicators for eight regions and city size categories.

2.1 Defining bequest motive variables

In surveys for 2007-2009 and 2018-2019, subjects answered the intention to bequeath their assets, the anticipated inheritance of housing, and the plan of using the inherited houses. We define a dummy variable for bequest motives based on the following question: "Would you like to leave the asset of yours and your spouse's to heirs excluding your spouse?" The bequest motive dummy takes a value of one if the answer is yes and zero otherwise.[5] Table 1 contrasts bequest motives before the 2015 tax change (from the 2007-2009 surveys) and those after the tax change (from the 2018 survey). These descriptive statistics give indirect evidence of a positive bequest elasticity,

[5] The 2007-2009 surveys asked about the bequest motive about real estate and financial assets conditional on the intention to bequeath some assets. In contrast, the 2018 survey asked about real estate and financial assets unconditionally: "Would you like to leave the asset of yours and your spouse's to heirs excluding your spouse?" Respondents need to select one option from the four options in the bequest intention: 1) Yes, 2) No, 3) Do not have the asset, and 4) Do not know. We treat the first options having the bequest motive and we treat other options as having no bequest motive.

which Piketty and Saez (2013) consider a critical factor that determines the optimal inheritance tax rate. We test the effect of inheritance tax on bequest motives in our empirical analysis.

Table 1 **Frequencies of Reported Bequest Motives**

Real Estate				Financial Assets			
Year	No	Yes	Total	Year	No	Yes	Total
2006	1,651	595	2,246	2006	1,711	535	2,246
	(73.51)	(26.49)	(100.00)		(76.18)	(23.82)	(100.00)
2007	2,217	931	3,148	2007	2,309	837	3,146
	(70.43)	(29.57)	(100.00)		(73.39)	(26.61)	(100.00)
2008	2,092	848	2,940	2008	2,134	807	2,941
	(71.16)	(28.84)	(100.00)		(72.56)	(27.44)	(100.00)
2017	2,136	1,627	3,763	2017	2,319	1,450	3,769
	(56.76)	(43.24)	(100.00)		(61.53)	(38.47)	(100.00)
2018	1,821	1,658	3,479	2018	1,939	1,544	3,483
	(52.34)	(47.66)	(100.00)		(55.67)	(44.33)	(100.00)
Total	9,917	5,659	15,576	Total	10,412	5,173	15,585
	(63.67)	(36.33)	(100.00)		(66.81)	(33.19)	(100.00)
Pearson's Chi2 =497.909, p=0.00				Pearson's Chi2 = 436.616 , p=0.00			

Note: This table contrasts bequest motives regarding real and financial assets for different survey years. The year in the table corresponds to one year prior to the survey year; e.g., the 2006 figures are taken from the 2007 survey. In parentheses are the proportions for each year. Each panel also shows Pearson χ^2 test for the null hypothesis that responses do not vary by year.

2.2 Defining underutilization

We construct two measures of housing underutilization. The first is a simple difference between the number of rooms and the number of household members. We call this measure excess rooms:

$$\textit{Excess rooms} = \textit{the number of rooms} - \textit{the number of household members.}$$

It is a crude measure but can be computed for all households in the sample. Admittedly, not all excess rooms are truly excessive because they potentially include intentional underutilization

based on dynamic optimization (Edin and Englund, 1991). For example, a household may keep several rooms unused when it anticipates co-living with a child's household in the near future. Although this first measure includes intentional underutilization, it would proxy true underutilization.

Figure 2 depicts the age profile of excess rooms for movers, non-movers, and renovators. The number of excess rooms is generally increasing in age for all household types. However, non-movers have more excess rooms than movers for almost all ages. Furthermore, the rate of increase by age is larger for non-movers than for movers. Thus, the empty nest problem is more pronounced in non-mover households.

Interestingly, renovators tend to have even more excess rooms. Renovations include modernization and changing the number of rooms, either positively or negatively. Thus, forward-looking capacity expansion can result in more excess rooms until they are actually used. However, after 50 years old, the number of excess rooms does not increase with age. This may suggest that relatively old household heads renovate their houses to decrease the number of rooms by combining excess rooms or increasing the household size by accommodating coresident children.

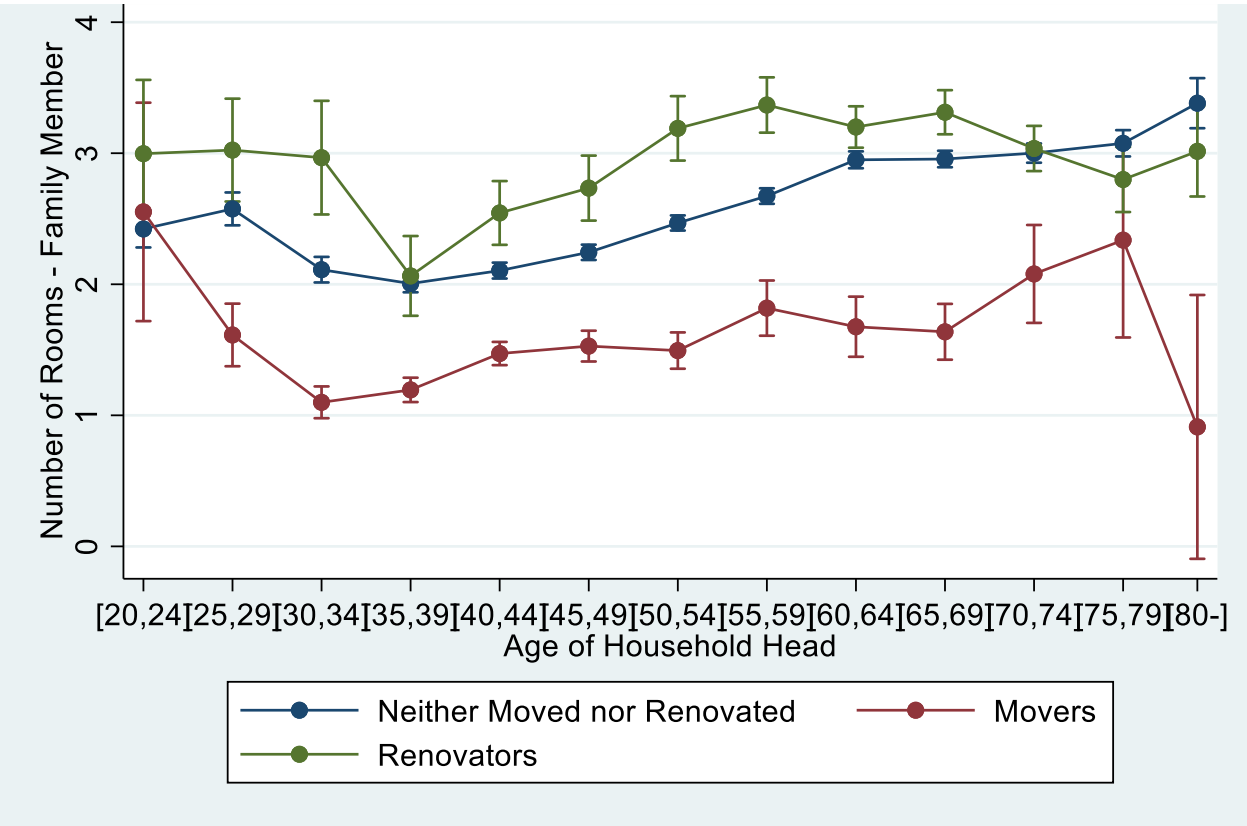

Figure 2 The Number of Excess Rooms

Note: This figure depicts the coefficients for age groups in columns four, five, and six of Table 10. The constant for each regression is added.

Our second measure of housing underutilization is based on the assumption that recent movers have no underutilization because they have dynamically optimized their housing capacity by taking into account future uses. Thus, we estimate the number of excess rooms (the first measure) for non-movers that exceeds the number of excess rooms for comparable recent movers. We call this measure the number of underutilized rooms. Specifically, we first construct matched pairs of movers and non-movers by using one-to-one propensity score matching. Then, for each pair, we construct the number of underutilized rooms for non-movers as:

$$\textit{Underutilized rooms} = \textit{excess rooms for non-movers} - \textit{excess rooms for movers}$$

This measure of underutilization is based on a conservative assumption that recent movers have no underutilized rooms. A disadvantage is that it can be computed only for non-movers.

Figure 3 depicts the estimated number of underutilized rooms by the age of the household head. Households are divided into those with and without recent renovations. The number of underutilized rooms is generally increasing in age for 35 years and older. The number of underutilized rooms is the largest for the oldest group, having approximately two to three underutilized rooms. For younger ages, the graph is generally downward sloping because households start to have children who occupy rooms. By comparing households with and without renovation, we find that those with renovation tend to have more underutilized rooms. In particular, the difference is significant for ages 45 to 59.[6]

[6] Appendix G shows additional properties of underutilized rooms.

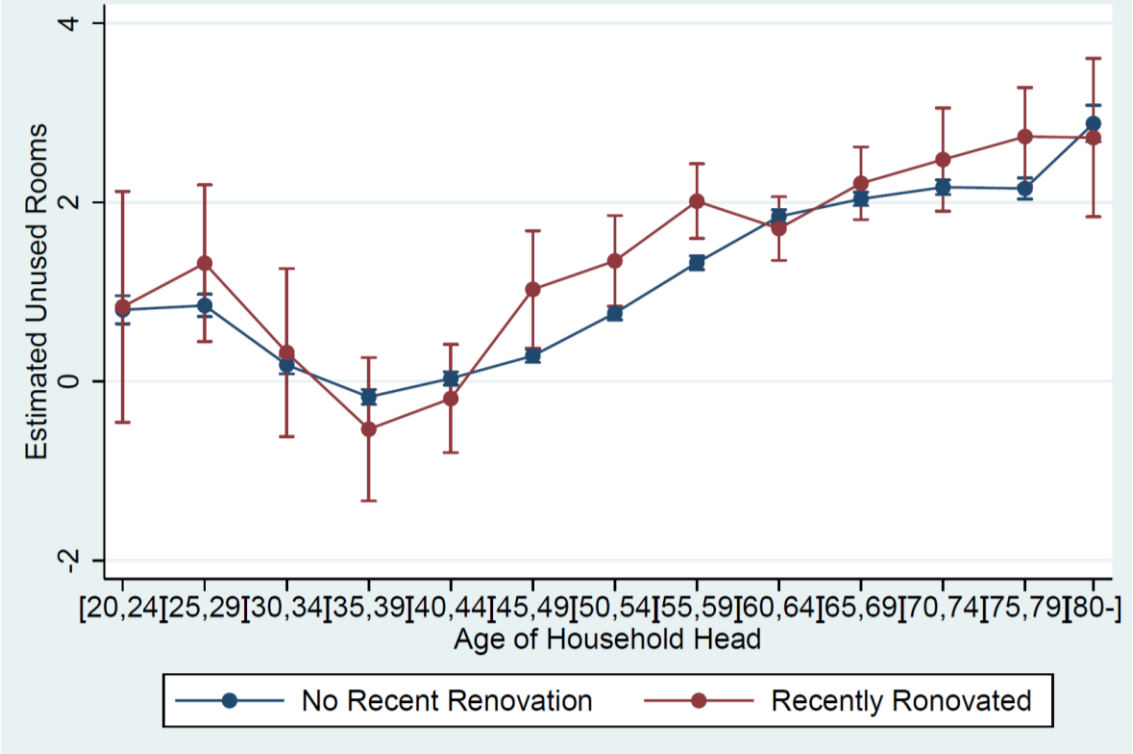

Figure 3 The Number of Underutilized Rooms

2.3 Descriptive statistics

Table 2 shows the descriptive statistics of three subsamples: (1) households that did not move or renovate housing, (2) households that moved housing in the previous year, and (3) households that renovated their houses in the previous year. Household income, savings, and home equity are deflated by the consumer price index (2015=100).

A majority of households did not move or renovate housing, confirming the low mobility of Japanese households.[7] Based on the average statistics in this sample, the number of rooms is 5.8, the average lot area is 231.7 m^2, 89% of houses are detached, 55% of houses are located in Kanto (Tokyo) and Kinki (Osaka) areas, and 71% of houses were built after 1981 when the building code incorporated the modern earthquake resistance requirement. The age of the household head is 54 years old, real income is 7 million JPY, and real financial wealth is 12 million JPY measured in the 2015 price. 35% of household heads have college degrees, 80% are married, 35% are full-time workers, and the average household size is 3.4 persons. The proportion of households that have the intention to bequeath is 43% for housing and 36% for financial assets.

The sample of movers is characterized by smaller lot size (163m^2), smaller real financial wealth (9 million JPY), younger age (42 years old), fewer children (0.7 coresident and 0.3 non-coresident children), a smaller proportion of being married (50%), a larger proportion of female household head (28%), and a larger proportion of full-time workers (49%). The proportions of households that have the intention to bequeath real estate and financial assets are smaller (28% and 30%, respectively).

The sample of renovators is characterized by a larger number of rooms (6.3), detached houses (93%), an older age (57 years old), fewer co-resident children (0.8), and more non-coresident children (0.9), higher real income (7.5 million JPY), and larger real financial wealth (14.8 million

[7] Attrition can be an issue because respondents who moved between two waves may drop out of the sample. To alleviate this problem, we checked the original interviewer's survey data and identified movers from stayers in the dropped sample.

JPY). The proportions with bequest motives are larger (54% for housing and 45% for financial assets).

Table 2 Descriptive Statistics

	(i) Households that did not move or renovate housing in 2006-2009 or 2017-2018		(ii) Households that moved in 2006-2009 or 2017-2018			(iii) Households that renovated housing in 2006-2009 or 2017-2018		
Variable	Mean	S. D.	Mean	S. D.	(ii)-(i)	Mean	S. D.	(iii)-(i)
Number of excess rooms(t+1)	2.534	2.080	1.224	1.555	***	3.210	2.151	***
Bequest motive for real estate (t+1) (=1)	0.429	0.495	0.277	0.449	***	0.543	0.499	***
Bequest motive for real estate (excluding inter vivos)(t+1) (=1)	0.436	0.496	0.297	0.459	***	0.548	0.499	***
Bequest motive for financial asset (t+1) (=1)	0.364	0.481	0.297	0.459	*	0.447	0.498	***
Bequest motive for financial asset (excluding inter vivos)(t+1) (=1)	0.387	0.487	0.319	0.468	*	0.478	0.501	***
Lot area, m2	231.7	398.3	163.0	213.1	***	288.8	316.8	***
Lot area, m2 [0,100] (=1)	0.736	0.441	0.824	0.382	***	0.607	0.489	***
Lot area, m2 (240,330] (=1)	0.117	0.322	0.108	0.312		0.165	0.372	**
Lot area, m2 (>330) (=1)	0.147	0.354	0.068	0.252	***	0.228	0.421	***
After inheritance tax change (=1)	0.465	0.499	0.358	0.481	***	0.382	0.487	***
# of rooms	5.768	1.850	5.547	1.763		6.279	2.124	***
# of rooms [1,3] (=1, Reference)	0.051	0.220	0.061	0.240		0.034	0.181	
# of rooms [4 or over] (=1)	0.940	0.238	0.939	0.240		0.959	0.199	
# of rooms: missing (=1)	0.009	0.096	0.000	0.000	***	0.007	0.086	
Detached house (=1)	0.887	0.317	0.831	0.376	*	0.925	0.264	**
Town house (=1)	0.010	0.100	0.020	0.141		0.007	0.086	
Condominium (=1)	0.127	0.333	0.176	0.382		0.079	0.270	***
Wooden apartment (=1)	0.001	0.035	0.000	0.000	***	0.004	0.061	
Other types of houses (=1)	0.001	0.035	0.000	0.000	***	0.000	0.000	***
Ground lease (=1)	0.024	0.154	0.027	0.163		0.011	0.106	*
Real housing equity (10,000JPY)	1,532	2,106	1,492	2,312		1,722	2,157	
Real housing equity is missing (=1)	0.164	0.371	0.155	0.364		0.157	0.365	
Built after 1981 (=1)	0.706	0.456	0.682	0.467		0.640	0.481	**
Age of household head	53.640	13.865	41.858	14.875	***	56.551	12.907	***
Real Income (10,000JPY)	693.2	454.9	820.5	842.4	*	747.2	474.8	*
Real income: missing (=1)	0.037	0.188	0.014	0.116	**	0.026	0.160	
Real financial wealth (10,000JPY)	1,160	1,973	944	1,875		1,481	1,885	***
Real financial wealth is missing (=1)	0.030	0.172	0.007	0.082	***	0.034	0.181	
College graduate (=1)	0.347	0.476	0.412	0.494		0.348	0.477	

Married (=1)	0.786	0.410	0.500	0.502	***	0.768	0.423	
Female household head (=1)	0.160	0.366	0.284	0.452	***	0.184	0.388	
Single (=1)	0.052	0.222	0.061	0.240		0.056	0.231	
Full-time worker (=1)	0.352	0.478	0.493	0.502	***	0.292	0.456	**
Part-time worker (=1)	0.132	0.338	0.203	0.403	**	0.161	0.368	
Retired (=1)	0.165	0.371	0.041	0.198	***	0.184	0.388	
# of family members	3.356	1.381	3.439	1.346		3.146	1.294	***
Family decreased since 2004 (=1)	0.112	0.315	0.162	0.370		0.150	0.358	*
Male children (=1)	0.551	0.497	0.392	0.490	***	0.479	0.501	**
# of non-coresident children	0.689	1.024	0.270	0.686	***	0.929	1.244	***
# of coresident children	1.020	1.042	0.716	0.976	***	0.768	0.896	***
No child (=1)	0.213	0.410	0.486	0.502	***	0.213	0.411	
Hokkaido (=1)	0.044	0.206	0.034	0.181		0.045	0.209	
Tohoku (=1)	0.056	0.231	0.041	0.198		0.030	0.172	**
Kanto (=1)	0.341	0.474	0.372	0.485		0.311	0.464	
Chubu (=1)	0.162	0.368	0.149	0.357		0.167	0.373	
Kinki (=1)	0.208	0.406	0.243	0.430		0.186	0.390	
Chugoku (=1)	0.053	0.225	0.027	0.163	*	0.083	0.277	*
Shikoku (=1)	0.031	0.174	0.027	0.163		0.034	0.182	
Kyushuu/Okinawa (=1)	0.104	0.305	0.108	0.312		0.144	0.352	*
Year 2006 (=1)	0.146	0.353	0.196	0.398		0.176	0.382	
Year 2007 (=1)	0.199	0.399	0.236	0.426		0.225	0.418	
Year 2008 (=1)	0.190	0.393	0.209	0.408		0.217	0.413	
Year 2017 (=1)	0.246	0.431	0.236	0.426		0.172	0.378	***
Year 2018 (=1)	0.219	0.414	0.122	0.328	***	0.210	0.408	
Number of observations	10,608		148			267		

Note: ***, **, and * indicate the result of a paired t-test of equal means between two samples at the 1%, 5%, and 10% significance levels, respectively. We use Welch's method to test the difference of averages under the hypothesis of heteroskedasticity.

3 The overall effect of bequest motive on excess rooms

Our research hypothesis is that a person's bequest motive causes the underutilization of housing. We first estimate the overall effect of bequest motives on housing underutilization in this section. We will analyze several potential action channels in Section 4. A challenge in estimating the causal relation between bequest motives and underutilization is endogeneity. Some confounders may cause both bequest motives and housing underutilization. For example, a household that

anticipates living with a child's household may maintain extra unused rooms and also desire to bequeath the house. To address confounder issues, we include a rich set of housing and household characteristics. Another challenge is reverse causality. For example, a household that happened to buy a large house for a reasonable price may start to consider bequeathing the house. Alternatively, a household that modernized its house with some extra rooms may start to consider bequeathing the renovated house.

To address the reverse causality and unobserved confounders, we construct a vector of instrumental variables by using a change in inheritance taxes. We use two-stage least squares (TSLS) estimation. In the first stage (equation (1)), we regress the real estate bequest motive on the vector of instrumental variables, control variables, and region and year fixed effects:

$$B^H{}_{\text{it}} = \boldsymbol{z}'_{it-1}\boldsymbol{\gamma_z} + \boldsymbol{x}'_{it-1}\boldsymbol{\gamma_x} + J_j + T_t + u_{it}, \quad (1)$$

where $B^H{}_{\text{it}}$ denotes the indicator for household i's bequest motives for real estate, $\boldsymbol{z}_{it-1}$ denotes the vector of instrumental variables, $\boldsymbol{x}_{it-1}$ denotes the covariate vector related to households and housing characteristics, J_j and T_t denote region and year fixed effects, respectively, and u_{it} denotes the error term. In the second stage (equation (2)), we regress our measure of housing underutilization on the instrumented bequest motive and covariates, including region and year fixed effects:

$$r_{it}^e = \alpha_B \widehat{B^H}_{it} + \boldsymbol{x}'_{it-1}\boldsymbol{\alpha_x} + J_j + T_t + w_{it}, \quad (2)$$

where r_{it}^e is either excess rooms or underutilized rooms, as defined in Section 2, $\widehat{B^H}_{it}$ denotes the instrumented bequest motive obtained from the first stage, and w_{it} is the error term. This TSLS estimation is schematically summarized in Figure 4 (Appendix A). The arrows connecting

$\boldsymbol{z}_{it-1} \rightarrow B^H{}_{\text{it}}$ and $\boldsymbol{x}_{it-1} \rightarrow B^H{}_{\text{it}}$ represent the first stage estimation, and the arrows connecting $B^H{}_{\text{it}} \rightarrow r_{it}^e$ and $\boldsymbol{x}_{it-1} \rightarrow r_{it}^e$ represent the second stage estimation.[8]

The covariate vector $\boldsymbol{x}_{it-1}$ includes housing characteristics, household income and wealth, marital status, and children (see Table 2). In particular, we include detailed children characteristics: the number of family members, a dummy for family decreased since 2004, a dummy for male children, the number of non-coresident children, and the number of coresident children.[9]

The instrument vector $\boldsymbol{z}_{it-1}$ should include the variables that are correlated with real estate bequest motives but have no effect on the outcome other than through the first stage. We employ a set of instrumental variables that capture a major change in the inheritance tax code in 2015. The 2015 change increased the size limit for the residential lot assessment reduction. The tax assessment of a residential lot was reduced by 80% up to 240 m^2 before the tax change but up to 330 m^2 after the change.[10] This assessment reduction is a significant tax benefit for bequeathing assets in the form of real estate instead of financial assets. This tax change benefits all residential lots greater than 240 m^2. Furthermore, the 240 and 330 thresholds are unique to inheritance taxes and unrelated to any other taxes. Thus we construct dummy variables for small lots ($\leq$ 240 m^2),

[8] As a preliminary analysis, we estimate equation (2) by OLS. The result is reported in Appendix B.
[9] Different types of children can be associated with alternative hypotheses about bequest motives.: selfish, altruistic, and dynastic motives. Horioka (2002, 2014) and Hamaaki et al. (2018) find that bequest motives in Japan are consistent with selfish and dynastic motives. Selfish parents will not bequeath assets to their children unless they live together and take care of parents.
[10] The 2015 tax change also includes the general changes that affect both real estate and financial assets. These include an increase in the maximum tax rate from 50% to 55%, a decrease in the basic exemption from 50 to 30 million JPY, and a decrease in the additional exemption limit from 10 to 6 million JPY per heir. Overall, the 2015 tax change increased an inheritance tax amount.

medium lots (240 m^2 < lot size ≤ 330 m^2), and large lots (> 330 m^2) and interact these dummy variables with a post-2015 dummy.

The key identifying assumption is a stable relationship between real estate bequest motives by large-lot owners and those by other households in the absence of the 2015 inheritance tax change. We check this assumption by placebo tests using a falsified year of a tax change (2008). Table 19 in Appendix E show no significant coefficient on the interaction terms between lot size dummies and the falsified tax change dummy. Thus, we confirm the parallel trend assumption, which is necessary for identifying the change in the bequest motives induced by the 2015 tax changes.

3.1 Results based on excess rooms

Table 3 shows the results for the overall effect of real estate bequest motives on the number of excess rooms.[11] According to the first specification (columns 1 and 2), the coefficient on the instrumented bequest motive for real estate on the number of excess rooms is 0.07714. Because the bequest probability is expressed in percentage, this coefficient indicates that a one-percentage-point larger probability of having a real estate bequest motive results in 0.08 more excess rooms on average. We test the validity of the first stage IV model in three ways. By the Kleibergen-Paap rk LM test (Kleibergen and Paap, 2006), we can reject the null hypothesis of under-identification. By the Kleibergen-Paap Wald rk F statistic, we reject the null of weak instruments at least ten percent based on the critical values (10% maximal IV relative bias, 10.27) provided by Stock and

[11] More detailed results for the first stage regression are reported in Appendix D.1 (Table 13).

Yogo (2005). By Hansen's over-identification J test, we do not reject the null of the orthogonality condition.

In the second specification (columns 3 and 4), we include the interaction term between the lot area and the post-tax dummy. This specification controls for the possibility that the number of excess rooms has generally changed after the tax change regardless of size limit thresholds. The estimated coefficient on the instrumented bequest motive for real estate increases to 0.09579. Thus, a 1% higher probability of having a real estate bequest motive results in 0.10 more excess rooms. However, the result of Kleibergen-Paap Wald rk F statistic shows a lower value of 8.509, which indicates that we cannot reject the hypothesis of weak instruments. Thus, we mainly discuss based on the first specification.

Table 3 TSLS Estimation of the Excess Room Model

Dependent Variable	1. Bequest Motives for Real Estate (1st stage)	2. N. of Excess Rooms (2nd stage)	3. Bequest Motives for Real Estate (1st stage)	4. N. of Excess Rooms (2nd stage)
Bequest motive for real estate (t+1) (%)		0.07714***		0.09579***
		-0.01337		(0.01778)
Lot area, m2 (240,330] (=1)	0.00346		0.00114	
	(0.0195)		(0.0196)	
Lot area, m2 (>330) (=1)	0.123***		0.115***	
	(0.0194)		(0.0209)	
Lot area, m2 (240,330] ×tax change (=1)	-0.0135		-0.00828	
	(0.0280)		(0.0284)	
Lot area, m2 (>330)×tax change (=1)	-0.103***		-0.0833***	
	(0.0261)		(0.0310)	
After tax-change (=1)	0.153***	-1.338***	0.156***	-1.734***
	(0.0154)	(0.219)	(0.0157)	(0.309)
Lot area, 100m2	0.00219*	0.0229*	0.00347*	-0.0164
	(0.00127)	(0.0138)	(0.00178)	(0.0220)
Lot area×tax change (=1)			-0.00301	0.0665**
			(0.00259)	(0.0271)
Housing characteristics	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes
Fixed Effects (city sizes, region and year)	Yes	Yes	Yes	Yes

# of observations	10,635	10,635	10,635	10,635
R-squared	0.150	-2.255	0.150	-3.772
Kleibergen-Paap rk LM	41.54	[0]	31.05	[0]
Kleibergen-Paap Wald rk F	10.75		8.509	
Hansen J	45.57	[0.000]	26.68	[0.000]

Note: Cluster standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1.

Table 4 shows the second-stage estimation result for subsamples. Column 1 shows the result when we exclude households intending to make inter vivos transfers from the 2018 sample. The coefficient on the instrumented bequest motive for real estate is 0.072 and approximately equal to our main estimate. Columns 2 and 3 show the results for different age groups. The effect of real estate bequest motives on excess rooms is larger than the main estimate for elderly households (0.093). This coefficient suggests that an elderly household has one more excess room if it is 10.8% more likely to have a real estate bequest motive. This result is consistent with our hypothesis that a larger number of excess rooms held by the older population is driven at least partially by bequest motives. However, the effect is also statistically significant for working-age households (0.047) despite a smaller magnitude. This result is striking because the tax-induced bequest motive affects the housing capacity choice even before 60 years old. These households may maintain excess capacity for more than 20 years on average, given the average lifespan of 81.5 years for males and 87.6 years for females. Columns 4 and 5 show subsamples by region. The effect of bequest motives is larger in large metro areas than in non-metro areas, although the effect is statistically significant for both regions. Housing in large metropolitan areas may be preferable to housing in rural areas because a large fraction of younger generations live in large metropolitan areas.

Table 4 Subsample Analysis of the Effect of Bequest Motives on Excess Rooms

Variables	1.Excluding the intention of inter vivos in 2018 sample	2. The working-age household head (<60)	3. The elderly household head (>=60)	4.Metropolitan areas	5. Non-metropolitan areas
Bequest motive for real estate (t+1) (%)	0.07154***	0.04650***	0.09343***	0.09426***	0.05997***
	(0.01270)	(0.01190)	(0.02309)	(0.02303)	(0.01564)
Lot area×tax change (=1)	No	No	No	No	No
Housing characteristics	Yes	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes	Yes
Fixed Effects (city sizes, region and year)	Yes	Yes	Yes	Yes	Yes
# of observations	9,991	6,781	3,854	5,878	4,757
R-squared	-1.820	-0.631	-4.349	-4.511	-1.057
Kleibergen-Paap rk LM	41.56	26.57	19.63	17.51	21.44
	[0.000]	[0.000]	[0.000]	[0.002]	[0.000]
Kleibergen-Paap Wald rk F	10.777	6.962	4.83	4.801	5.391

Note: The estimate is the coefficient β_B on the instrumented bequest motives for real estate in the second-stage linear mobility regression. Regions with large metropolitan areas are Tokyo, Kanagawa, Chiba, Saitama, Aichi, Osaka, Kyoto, Hyogo, and Fukuoka. Heteroskedasticity consistent standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1. Coefficients of other variables are suppressed.

3.2 Results based on underutilized rooms

Table 5 shows the estimation results when we use the number of underutilized rooms for the outcome. The sample is restricted to non-movers because this measure is based on the assumption that recent movers have no underutilized rooms (see Section 2). For both the first and second specifications, the second-stage coefficients on the instrumented bequest motive (0.07185 in column 2 and 0.09738 in column 4) are similar to those for excess rooms reported in Table 3. Although these two measures of underutilization differ in levels, the marginal effect of bequest motives is approximately the same. These results suggest that the effect of bequest motives on underutilization can be consistently estimated, either with simple excess rooms or underutilized rooms that cannot be explained by dynamic optimization.

Table 5 TSLS Estimation of the Underutilized Room Model

Dependent Variable	1. Bequest Motives for Real Estate (1^{st} stage)	2. N. of underutilized rooms (2nd stage)	3. Bequest Motives for Real Estate (1^{st} stage)	4. N. of underutilized rooms (2^{nd} stage)
Bequest motive for real estate (t+1) (%)		0.07185***		0.09738***
		(0.0185)		(0.02941)
Lot area, m2 (240,330] (=1)	-0.0121		-0.0186	
	(0.0259)		(0.0259)	
Lot area, m2 (>330) (=1)	0.114***		0.0919***	
	(0.0273)		(0.0283)	
Lot area, m2 (240,330] ×tax change (=1)	-0.00647		0.00683	
	(0.0352)		(0.0356)	
Lot area, m2 (>330)×tax change (=1)	-0.105***		-0.0589	
	(0.0322)		(0.0377)	
Lot area, m2	2.89e-05	0.000305*	6.48e-05***	-0.000252
	(1.76e-05)	(0.000174)	(2.11e-05)	(0.000359)
Lot area×tax change (=1)			-7.51e-05**	0.000842**
			(3.25e-05)	(0.000418)
Housing characteristics	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes
Fixed Effects (city sizes, region and year)	Yes	Yes	Yes	Yes
# of observations	9,036	9,036	9,036	9,036
R-squared	0.149	-1.096	0.150	-2.288
Kleibergen-Paap rk LM	20.36	[0.000]	13.23	[0.000]
Kleibergen-Paap Wald rk F	5.447		3.513	

Note: The estimate is the coefficient on the instrumented bequest motives for real estate in the second-stage linear mobility regression. Regions with large metropolitan areas are Tokyo, Kanagawa, Chiba, Saitama, Aichi, Osaka, Kyoto, Hyogo, and Fukuoka. Clustered standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1.

Table 6 shows the second-stage estimation results for subsamples. The estimated coefficients are generally consistent with those in Table 4 based on excess rooms. The effect of bequest motives on underutilized rooms becomes slightly smaller (0.068) if we exclude inter vivos transfer (column 1), but the difference is small relative to standard errors. The effect is smaller for working-age households (0.039, column 2) than for elderly households (0.092, column 3), consistent with our hypothesis. However, even working-age households keep underutilized rooms because of real

estate bequest motives. Finally, the effect is larger in large metropolitan areas than in non-metro areas, possibly because housing in urban locations are preferred by their heirs.

Table 6 Subsample Analysis of the Effect of Bequest Motives on Underutilized Rooms

Variables	1.Excluding the intention of inter vivos in 2018 sample	2. The working-age household head (<60)	3. The elderly household head (>=60)	4.Metropolitan areas	5. Non-metropolitan areas
Bequest motive for real estate (t+1)(%)	0.06763***	0.03918***	0.09197***	0.0865***	0.04914***
	(0.01576)	(0.01449)	(0.02709)	(0.02724)	(0.01824)
Lot area×tax change (=1)	No	No	No	No	No
Housing characteristics	Yes	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes	Yes
Fixed Effects (city sizes, region and year)	Yes	Yes	Yes	Yes	Yes
# of observations	8,709	5,708	3,328	5,193	3,843
R-squared	-0.918	-0.173	-2.493	-1.821	-0.393
Kleibergen-Paap rk LM	28.80	21.11	14.75	12.68	15.84
	[0]	[0]	[0.005]	[0.013]	[0.003]
Kleibergen-Paap Wald rk F	7.467	5.407	3.583	3.512	3.975

Note: The estimate is the coefficient β_B on the instrumented bequest motives for real estate in the second-stage linear mobility regression. Regions with large metropolitan areas are Tokyo, Kanagawa, Chiba, Saitama, Aichi, Osaka, Kyoto, Hyogo, and Fukuoka. Heteroskedasticity consistent standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1. Coefficients of other variables are suppressed.

4 Action channels

Bequest motives can affect housing utilization through several action channels. One channel is through mobility decisions. If a person intends to bequeath a house instead of financial assets, the person may refrain from selling the house and continue living in it even though the house becomes undesirable for the person. For example, the house may be too large and distant from a medical facility for an elderly homeowner, but the person would not move to a more desirable house to

maintain the primary housing until death. We call this channel the mobility channel. Another channel is through renovation decisions. If a person has a bequest motive, then the person may renovate the house to increase its economic life span. Alternatively, if the person's bequest motive is "selfish" in the sense that it is liked to the person's expectation for care at home, then the person may renovate the house to accommodate two households. We call this channel the renovation channel.

We estimate causal relationships between real estate bequest motives and the number of excess rooms through mobility and renovation decisions by using the three-stage least squares (3SLS) estimation.[12] The first equation is a linear probability model for real estate bequest motives (equation (1)). We address endogeneity issues by using the instrument vector $\boldsymbol{z}_{it-1}$ specified in Section 3. The second equation is a linear probability model for a house-related action such as mobility and renovation:

$$y_{it} = \beta_B \widehat{B^H}_{it} + \boldsymbol{x}'_{it-1}\boldsymbol{\beta_x} + J_j + T_t + v_{it}, \tag{3}$$

where y_{it} denotes the indicator for an action related to housing (either moving or renovation) at time t, and $\widehat{B^H}_{it}$ denotes the instrumented bequest motive.[13] The third equation is a linear model

[12] See Greene (2018), pp.403-404 for details of the estimation method.

[13] As a preliminary analysis, we estimate equations (1) and (2) by several specifications and methods included in the appendix from A to F.

for the number of excess rooms r^e_{it} as a function of the probability of taking a house-related action:

$$r^e_{\mathrm{it}} = \alpha_{\mathrm{y}}\hat{y}_{it} + \boldsymbol{x}'_{it-1}\boldsymbol{\alpha}_{\mathrm{x}} + J_j + T_t + w^3_{it}, \quad (4)$$

where $\hat{y}_{it}$ denotes the estimated probability of taking a house-related action. For the outcome variable, we use excess rooms but not underutilized rooms because underutilized rooms are calculated only for non-movers. This 3SLS estimation is schematically summarized in Figure 4 (Appendix A). The arrows connecting $\boldsymbol{z}_{it-1} \rightarrow B^H{}_{\mathrm{it}}$ and $\boldsymbol{x}_{it-1} \rightarrow B^H{}_{\mathrm{it}}$ represents the first equation, the arrows connecting $B^H{}_{\mathrm{it}} \rightarrow y_{it}$ and $\boldsymbol{x}_{it-1} \rightarrow y_{it}$ represents the second equation, and the arrows connecting $y_{it} \rightarrow r^e_{it}$ and $\boldsymbol{x}_{it-1} \rightarrow r^e_{it}$ represents the third equation. We checked the rank condition for the identification of the parameters by checkreg3 command by STATA (Baum, 2007). As a robustness check, we also use TSLS to estimate the effect of beqest motive on mobility (Appendix D.2) and on renovation (Appendix D.3).[14]

4.1 Mobility channel

In the model for the mobility channel, the action variable y_{it} is a dummy variable for a recent move. The sample includes both movers and non-movers but excludes the households that renovated their houses during the sample period because we analyze renovation in the next section. In the covariate vector, we do not include the interaction term between the post-2015 dummy and

[14] As a preliminary analysis, we estimate equation (3) by OLS. The result is reported in Appendix C. Also, as a robustness check, we estimate equations (1) and (3) by TSLS without introducing equation (4) (Appendix D). Another robustness check is to estimate a non-linear IV probit models for mobility and renovation (Appendix F).

the lot size because of a better Kleibergen-Paap Wald rk F statistic in the first stage, as we discussed in Section 3.

Table 7 shows the estimation results. In the second equation (column 2), the instrumented bequest motive has a statistically significant negative effect on mobility. A one percentage point higher probability of bequest motives reduces the moving probability by 0.093 percentage points. This result is consistent with our expectation: A household should not move if it intends to bequeath the current house. In the third equation (column 3), the coefficient on the estimated probability of moving represents the marginal effect of mobility on the number of excess rooms. Because the probability is expressed in percentage in this stage, the coefficient -1.042 indicates that a one-percentage-point lower probability of bequest-driven mobility increases the number of excess rooms by 1.042 rooms. Thus, overall, a one-percentage-point higher probability of bequest motives is associated with 0.097 more excess rooms (0.093×1.042) through the mobility channel.

Table 7 3SLS Estimation of the Mobility Channel

Dependent Variable	1. Bequest Motives for Real Estate	2. Moving	3. Excess Rooms
Predicted Move (t+1) (%)			-1.042***
			(0.00894)
Bequest motive for real estate (t+1) (=1)		-0.0933***	
		(0.0128)	
Lot area, m2 (240,330] (=1)	0.0747***		
	(0.0165)		
Lot area, m2 (>330) (=1)	0.137***		
	(0.0199)		
Lot area, m2 (240,330] ×tax change (=1)	0.0393		
	(0.0324)		
Lot area, m2 (>330)×tax change (=1)	0.0248		
	(0.0238)		
After tax change (=1)	0.0941***	0.00863**	-0.317
	(0.0151)	(0.00382)	(0.251)

Lot area, 100m2	0.000205	0.000103	0.0136
	(0.00151)	(0.000347)	(0.0239)
Lot area×tax change (=1)	No	No	No
Housing characteristics	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes
Fixed effects(region and year)	Yes	Yes	Yes
Number of Observations	8,324	8,324	8,324

Note: Cluster standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1.

4.2 Renovation channel

In the model for the renovation channel, the action variable y_{it} is a dummy variable for a renovation during the sample period. The sample is restricted to non-movers and includes both renovators and non-renovators. Table 8 shows the estimation results for the renovation channel. In column 2, the instrumented bequest motive has a statistically significant positive effect on renovation. A one percentage point higher probability of bequest motives increases the renovation probability by 0.079 percentage points. In Appendix D, we further analyze the effect of bequest motives on different types of renovations. We find that the effect through the renovation channel is primarily associated with the capacity-increasing renovation (Table 17). The estimated coefficient is 0.092. Thus, a household intending to bequeath a house tends to renovate the house to increase the capacity, possibly to live with a child's household. In column 3, the coefficient on the estimated probability of renovation is positive and statistically significant. A one percentage point higher probability of renovation is associated with 0.793 more excess rooms. Thus, a one-percentage-point larger probability of bequest motives is associated with 0.063 more excess rooms (0.079×0.793) through the renovation channel. This effect is separate from the one through the

mobility channel because the mobility-channel effect does not include the effect through renovation. The mobility-channel effect is 54% larger than the renovation-channel effect.

Table 8 3SLS Estimation of the Renovation Channel

Dependent Variable	1. Bequest Motives for Real Estate	2. Renovation	3. Excess rooms
Predicted renovation (t+1) (%)			0.7929***
			(0.07516)
Bequest motive for real estate (t+1) (=1)		0.0789***	
		(0.0294)	
Lot area, m2 (240,330] (=1)	0.0374**		
	(0.0163)		
Lot area, m2 (>330) (=1)	0.141***		
	(0.0194)		
Lot area, m2 (240,330] ×tax change (=1)	-0.00254		
	(0.0145)		
Lot area, m2 (>330)×tax change (=1)	-0.00295		
	(0.0188)		
After tax change (=1)	0.145***	-0.0176***	0.226
	(0.0149)	(0.00666)	(0.253)
Lot area, 100m2	-0.000543	-4.78e-05	0.0342*
	(0.00132)	(0.000460)	(0.0205)
Lot area×tax change (=1)			
Housing characteristics	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes
Fixed effects (region and year)	Yes	Yes	Yes
# of observations	10,510	10,510	10,510

Note: Cluster standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1.

5 Relation with happiness

The JHPS also asked about perceived happiness in three different time spans: the recent week, the recent year, and the entire life. We test if the subjective well-being of households is correlated with

excess rooms. We estimate a linear model for perceived happiness as a function of the number of excess rooms, conditional on housing and household characteristics.

Table 9 shows the results. The coefficient on the number of excess rooms is negative and statistically significant for the recent week (-0.0726) and the recent year (-0.0795). A possibility is that the cost of maintaining excess housing capacity decreases happiness. Another possibility is that a person who does not feel happy in his or her life tends to intend to bequeath assets. However, column 3 shows that the coefficient is indistinguishable from zero for happiness for the entire life. Given that the number of excess rooms is associated with happiness in the recent past, we feel that the cost of maintaining underutilized housing may temporarily make a household less happy.

Table 9 Perceived Happiness and the Number of Excess Rooms

Variable	1. Happiness for the recent week	2. Happiness for the recent year	3. Happiness for the entire life
Number of excess rooms	-0.0726**	-0.0795**	-0.309
	(0.0341)	(0.0315)	(0.198)
Housing characteristics	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes
Regions fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
# of observations	24,868	24,869	24,869
R-squared	0.011	0.011	0.001
F-statistics for household fixed effects	5.477	6.751	1.460
	[0.000]	[0.000]	[0.000]

Note: Regions with large metropolitan areas are Tokyo, Kanagawa, Chiba, Saitama, Aichi, Osaka, Kyoto, Hyogo, and Fukuoka. Heteroskedasticity consistent standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1.

6 Conclusion

This study sheds light on the underutilization of housing stock in the aging society by focusing on a bequest motive and inheritance taxes. Our objective is to analyze how the intention to bequeath housing impacts housing underutilization through its effect on household mobility and renovation. By using the Japanese household panel survey (JHPS/KHPS), we demonstrate that (1) a real estate bequest motive causes housing underutilization, (2) the effect of bequest motives on underutilization is larger for elderly households and in large metropolitan areas but statistically significant also for working-age households and non-metropolitan areas, (3) a bequest motive affects underutilization by reducing mobility and boosting renovation, and (4) housing underutilization is associated with less perceived happiness. Our study is the first to point out the inefficiency of bequest-motivated underutilized housing in an aging society. Parental housing choices are more important than ever as many developed countries age rapidly. We also identify a new kind of tax distortion, contributing to the discussion of the optimal inheritance tax. Our study also calls for a new definition of the housing vacancy rate that incorporates housing underutilization.

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Appendix A: Diagram summarizing the empirical strategy

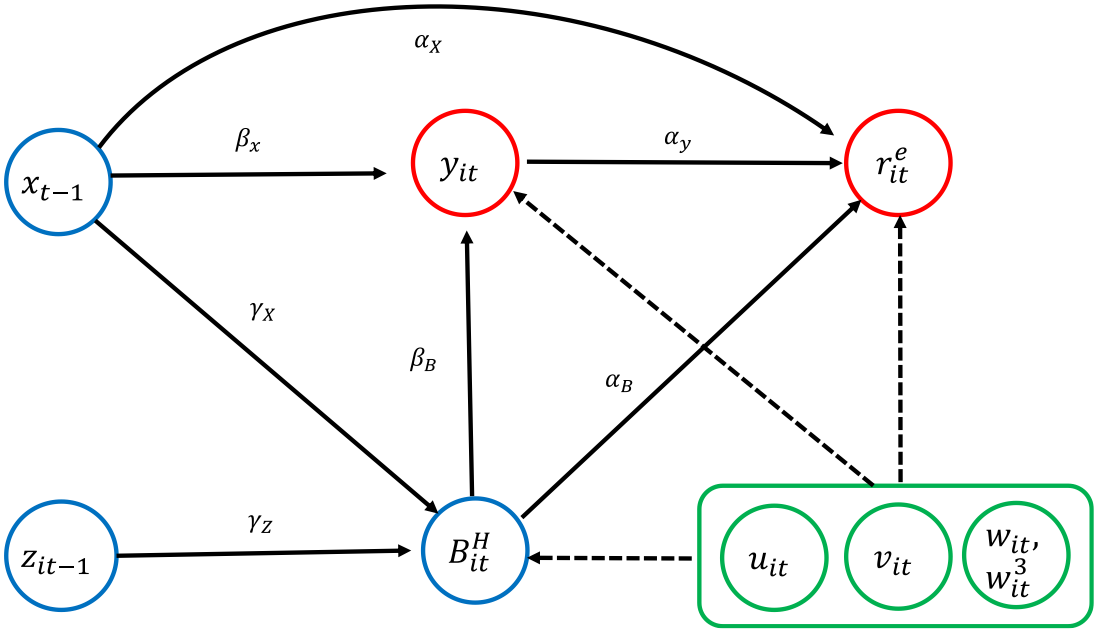

Figure 4 Directed Acyclic Graph

This figure depicts the empirical strategy in this study. The TSLS estimation in Section 3 is composed of the first stage equation (1) (the arrow labeled γ_z connecting $\boldsymbol{z}_{it-1} \rightarrow B^H{}_{\text{it}}$ and the arrow labled γ_x connecting $\boldsymbol{x}_{it-1} \rightarrow B^H{}_{\text{it}}$) and the second stage equation (2) (the arrow labeled α_B connecting $B^H{}_{\text{it}} \rightarrow r_{it}^e$ and the arrow labled α_x connecting $\boldsymbol{x}_{it-1} \rightarrow r_{it}^e$). The error terms in these equations are u_{it} and w_{it}. The 3SLS estimation in Section 4 is composed of the first stage equation (1) (the arrow labeled γ_z connecting $\boldsymbol{z}_{it-1} \rightarrow B^H{}_{\text{it}}$ and the arrow labled γ_x connecting $\boldsymbol{x}_{it-1} \rightarrow B^H{}_{\text{it}}$), the second stage equation (3) (the arrow labeled β_B connecting $B^H{}_{\text{it}} \rightarrow y_{it}$ and the arrow labled β_x connecting $\boldsymbol{x}_{it-1} \rightarrow y_{it}$), and the third stage equation (4) (the arrow labeled α_y connecting $y_{\text{it}} \rightarrow r_{it}^e$ and the arrow labled α_x connecting $\boldsymbol{x}_{it-1} \rightarrow r_{it}^e$). The error terms in these equations are u_{it}, v_{it}, and w_{it}^3.

Appendix B: OLS estimation of the excess room equation

As a preliminary analysis, we estimate the following equation for excess rooms by OLS for different subsamples:

$$r_{\mathrm{it}}^{e} = \boldsymbol{x}_{it-1}'\boldsymbol{\delta}_1 + J_j + T_t + \varepsilon_{1it},$$

where r_{it}^{e} denotes the number of excess rooms defined by the difference between the number of rooms and the number of persons for household i in year t.[15] Vector $\boldsymbol{x}_{it-1}$ includes a constant, household attributes such as household head's age categories, household size, the number of children, real income quartiles, and real financial wealth quartiles. Fixed effects are also included for region j, J_j $(j = 1, \cdots, 8)$, and year t, T_t.

Table 10 shows the estimation result. The numbers of family members and children have negative coefficients. Larger income and financial wealth are associated with more excess rooms, possibly because of their preferences for greater consumption of housing. High-income and wealthier households may be less sensitive to the opportunity cost of maintaining excess rooms. An opportunity-cost explanation is also consistent with the result that the more expensive Kanto (Tokyo) region has fewer excess rooms.

Constants for homeowners (column 2) and renters (column 3) indicate that homeowners tend to have more excess rooms. The larger number of excess rooms can be caused by homeowners' higher costs of adjusting housing either by moving or renovating. Homeowners may maintain a suboptimal amount of housing even when the household size changes because re-optimization requires the expenses associated with moving, buying a house, and selling the current house.

Non-movers (column 4) tend to hold more excess rooms than movers (column 5). Since movers already re-optimized housing consumption, unused housing space should be smaller, ceteris paribus. In addition to a larger constant for non-movers, their age coefficients are also significantly larger for all age groups.

Table 10 Excess-Room Regression Result

Dependent Variable:	1	2	3	4	5	6
# of Excess rooms	Whole Sample	Home-owners	Renters	No Move	Moved	Renovated
# of family members	-0.410***	-0.542***	-0.520***	-0.448***	-0.252***	-0.603***
	(0.00721)	(0.00805)	(0.0143)	(0.00784)	(0.0215)	(0.0256)

[15] A child under ten years old is counted as a half.

# of Children	-0.0751***	-0.0504***	-0.0321**	-0.0490***	-0.249***	0.0337
	(0.00752)	(0.00809)	(0.0144)	(0.00803)	(0.0229)	(0.0245)
Real income:	0.183***	0.0217	0.160***	0.191***	0.0989***	0.203***
2nd and 3rd quartiles (=1)	(0.0183)	(0.0204)	(0.0295)	(0.0206)	(0.0373)	(0.0769)
Real income:	0.454***	0.248***	0.404***	0.454***	0.381***	0.131*
4th quartile (=1)	(0.0204)	(0.0219)	(0.0465)	(0.0223)	(0.0487)	(0.0761)
Real financial wealth:	0.316***	0.165***	0.0487*	0.341***	0.136***	0.238***
2nd and 3rd quartiles (=1)	(0.0179)	(0.0197)	(0.0292)	(0.0200)	(0.0374)	(0.0734)
Real financial wealth:	0.702***	0.479***	0.252***	0.723***	0.435***	0.733***
4th quartile (=1)	(0.0201)	(0.0217)	(0.0461)	(0.0218)	(0.0496)	(0.0681)
Household head age (Reference: [40, 44])						
[20, 24] (=1)	0.190***	0.435***	-0.300***	0.318***	-0.561***	0.684**
	(0.0548)	(0.0627)	(0.0762)	(0.0585)	(0.152)	(0.346)
[25, 29] (=1)	-0.0528	0.388***	-0.343***	0.176***	-0.567***	0.404**
	(0.0409)	(0.0508)	(0.0485)	(0.0491)	(0.0668)	(0.187)
[30, 34] (=1)	-0.387***	-0.157***	-0.308***	-0.263***	-0.487***	0.0651
	(0.0327)	(0.0413)	(0.0435)	(0.0414)	(0.0523)	(0.184)
[35, 39] (=1)	-0.298***	-0.229***	-0.265***	-0.242***	-0.324***	-0.678***
	(0.0288)	(0.0331)	(0.0444)	(0.0349)	(0.0493)	(0.163)
[45, 49] (=1)	0.254***	0.197***	0.175***	0.253***	0.116**	0.267*
	(0.0286)	(0.0322)	(0.0466)	(0.0331)	(0.0546)	(0.143)
[50, 54] (=1)	0.524***	0.437***	0.219***	0.501***	0.286***	0.854***
	(0.0294)	(0.0329)	(0.0478)	(0.0332)	(0.0674)	(0.144)
[55, 59] (=1)	0.815***	0.681***	0.270***	0.783***	0.389***	0.956***
	(0.0304)	(0.0336)	(0.0501)	(0.0338)	(0.0774)	(0.139)
[60, 64] (=1)	1.111***	0.932***	0.342***	1.080***	0.446***	0.800***
	(0.0315)	(0.0347)	(0.0516)	(0.0349)	(0.0803)	(0.128)
[65, 69] (=1)	1.270***	1.010***	0.527***	1.222***	0.581***	0.881***
	(0.0321)	(0.0354)	(0.0559)	(0.0354)	(0.0885)	(0.128)
[70, 74] (=1)	1.358***	1.044***	0.629***	1.292***	0.655***	0.843***
	(0.0347)	(0.0378)	(0.0645)	(0.0382)	(0.0990)	(0.128)
[75, 79] (=1)	1.447***	1.115***	0.657***	1.371***	0.576***	0.596***
	(0.0428)	(0.0461)	(0.0797)	(0.0463)	(0.131)	(0.149)
[80 and above) (=1)	1.717***	1.428***	0.866***	1.675***	0.399**	0.843***
	(0.0673)	(0.0718)	(0.110)	(0.0701)	(0.156)	(0.169)
Regional fixed effects (Reference: Kanto area)						
Hokkaido (=1)	0.415***	0.397***	0.400***	0.441***	0.223***	0.665***
	(0.0283)	(0.0312)	(0.0411)	(0.0309)	(0.0628)	(0.0865)
Tohoku (=1)	1.171***	1.145***	0.624***	1.193***	0.811***	1.085***
	(0.0352)	(0.0378)	(0.0704)	(0.0377)	(0.0935)	(0.109)
Chubu (=1)	0.979***	0.980***	0.540***	1.014***	0.668***	1.004***
	(0.0221)	(0.0237)	(0.0423)	(0.0241)	(0.0517)	(0.0799)
Kinki (=1)	0.553***	0.544***	0.346***	0.575***	0.381***	0.942***
	(0.0197)	(0.0220)	(0.0298)	(0.0221)	(0.0398)	(0.0811)
Chugoku (=1)	0.906***	0.975***	0.554***	0.918***	0.629***	1.139***
	(0.0351)	(0.0399)	(0.0463)	(0.0381)	(0.0860)	(0.127)
Shikoku (=1)	0.843***	0.922***	0.361***	0.890***	0.604***	0.392***
	(0.0434)	(0.0471)	(0.0679)	(0.0487)	(0.0851)	(0.145)

Kyushuu/Okinawa (=1)	0.434***	0.489***	0.229***	0.487***	0.215***	0.718***
	(0.0230)	(0.0255)	(0.0342)	(0.0253)	(0.0501)	(0.0836)
Constant	2.226***	3.211***	1.790***	2.346***	1.970***	3.035***
	(0.0392)	(0.0458)	(0.0583)	(0.0444)	(0.0824)	(0.180)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
# of observations	71,960	57,804	12,613	60,718	10,771	6,114
R-squared	0.274	0.285	0.325	0.268	0.196	0.237

Note: Heteroskedasticity consistent standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1. Coefficients of missing categories are suppressed for the number of rooms, housing wealth, income, and financial wealth.

To better understand the relation between the number of unused rooms and moving and renovations, we run the following regressions:

$$r_{\mathrm{it}}^{e} = \alpha_2 m_{it-1} + \boldsymbol{r}'_{it-1}\boldsymbol{\gamma_2} + \boldsymbol{x}'_{it-1}\boldsymbol{\delta_2} + J_j + T_t + \varepsilon_{2it},$$

where m_{it-1} denotes the dummy variable for moving, and $\boldsymbol{r}_{it-1}$ denotes the vector of dummy variables for different types of renovations (capacity-increasing, maintaining, and decreasing renovations).

Table 11 shows the estimation result. When we do not control for an attribute or fixed effects, moving during the previous year is associated with 1.351 fewer excess rooms on average, suggesting the optimization of housing consumption at the time of move (Column one). Renovation on average is associated with 0.652 more excess rooms (Column two), mainly driven by a capacity-increasing renovation adding 1.754 rooms (Column four). When we control for housing and household attributes and fixed effects for region and year, estimated coefficients slightly decrease in magnitude, but the main conclusion is unchanged. Based on column eight, moving is subsequently associated with 1.0 fewer unused rooms, whereas a capacity-increasing renovation is associated with 1.5 more excess rooms. Thus, unused rooms are negatively correlated with household mobility and positively correlated with renovations on average.

Table 11: Number of excess rooms, mobility, and renovation

Dependent Variable: # of Excess rooms	1	2	3	4	5	6	7	8
Moving (=1)	-1.351***		-1.334***	-1.334***	-1.034***		-1.030***	-1.032***
	(0.126)		(0.126)	(0.126)	(0.147)		(0.147)	(0.147)
Renovation (=1)		0.652***	0.635***			0.208*	0.196*	
		(0.129)	(0.129)			(0.117)	(0.117)	
Capacity-increasing renovation (=1)				1.754***				1.531***
				(0.296)				(0.277)
Capacity-maintaining renovation (=1)				0.612***				0.0804
				(0.158)				(0.133)

Capacity-decreasing renovation (=1)				-0.332				-0.730***
				(0.236)				(0.220)
Housing and household attributes	No	No	No	No	Yes	Yes	Yes	Yes
Region and year fixed effects	No	No	No	No	Yes	Yes	Yes	Yes
Constant	2.548***	2.514***	2.532***	2.532***	-1.035***	-1.144***	-1.024***	-1.024***
	(0.0197)	(0.0198)	(0.0199)	(0.0199)	(0.285)	(0.284)	(0.285)	(0.284)
Observations	12,024	12,024	12,024	12,017	10,702	10,702	10,702	10,700
R-squared	0.005	0.002	0.007	0.010	0.473	0.471	0.473	0.477

Note: Heteroskedasticity consistent standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1.

Appendix C: OLS estimations of the mobility and renovation equations

As a preliminary analysis, we estimate the following equation for moving and renovation dummies by OLS to demonstrate correlations between moving/renovation and various house and household characteristics in a multivariate setting:

$$y_{it} = \beta_{A1} B_{it}^{H} + \boldsymbol{x}'_{\boldsymbol{it-1}} \boldsymbol{\delta_{A1}} + J_j + T_t + \varepsilon_{A1it},$$

where y_{it} denotes the indicator for moving or renovating of homeowner i in the following year, B_{it}^{H} denotes the indicator for the intention to bequeath real estate, $\boldsymbol{x_{it-1}}$ denotes the covariate vector including the variables related to households and housing characteristics, and $J_j (j = 1, \cdots, 8)$ and T_t are region and year fixed effects, respectively. Table 12 shows the OLS estimation results.

Table 12 Preliminary OLS regressions for Moving and Renovation

Dependent Variable	1. Moving	2. Moving	3. Renovation	4. Renovation
Variables				
Bequest motive for real estate (t+1) (=1)	-0.00167	-0.00163	0.0109***	0.0108***
	(0.00217)	(0.00217)	(0.00335)	(0.00335)
After tax change (=1)	-0.00452	-0.00518	-0.00840*	-0.00654
	(0.00348)	(0.00361)	(0.00486)	(0.00486)
Lot area, 100m2	-0.000442***	-0.000573**	0.000366	0.000735
	(0.000161)	(0.000248)	(0.000319)	(0.000507)
Lot area×tax change (=1)		0.000304		-0.000854
		(0.000329)		(0.000633)
# of rooms [4 or over] (=1)	0.000421	0.000406	0.00261	0.00265
	(0.00572)	(0.00572)	(0.00582)	(0.00582)
# of rooms: missing (=1)	-0.00993*	-0.00994*	-0.000302	-0.000264
	(0.00562)	(0.00562)	(0.0155)	(0.0155)
Condominium (=1)	0.00561	0.00564	-0.00387	-0.00396
	(0.00462)	(0.00462)	(0.00441)	(0.00441)
Ground lease (=1)	-0.00771	-0.00774	-0.00831	-0.00823
	(0.00884)	(0.00885)	(0.00790)	(0.00790)
Real housing equity, ln	0.000326	0.000328	-2.56e-05	-3.11e-05
	(0.000302)	(0.000302)	(0.000341)	(0.000341)
Real housing equity is missing (=1)	-0.000418	-0.000381	0.000635	0.000531
	(0.00375)	(0.00376)	(0.00457)	(0.00457)
Built after 1981 (=1)	-0.00316	-0.00316	-0.00282	-0.00282
	(0.00298)	(0.00298)	(0.00389)	(0.00390)
Age of household head(/10)	-0.0430***	-0.0428***	0.0151**	0.0146*
	(0.00858)	(0.00859)	(0.00769)	(0.00772)
Age of household head(squared, /100)	0.00342***	0.00341***	-0.00125	-0.00119

	(0.000763)	(0.000764)	(0.000771)	(0.000773)
Real income, ln	0.00396*	0.00396*	0.00615**	0.00613**
	(0.00235)	(0.00235)	(0.00267)	(0.00267)
Real income: missing (=1)	0.0108	0.0108	0.0287	0.0288
	(0.0153)	(0.0153)	(0.0183)	(0.0183)
Real financial wealth, ln	-0.000171	-0.000169	0.00196***	0.00196***
	(0.000490)	(0.000490)	(0.000534)	(0.000534)
Real financial wealth is missing (=1)	-0.000672	-0.000612	0.0162	0.0161
	(0.00399)	(0.00400)	(0.0111)	(0.0111)
College graduate (=1)	0.00248	0.00247	-0.00122	-0.00122
	(0.00261)	(0.00261)	(0.00344)	(0.00344)
Married (=1)	-0.00637	-0.00639	-0.00692	-0.00686
	(0.00517)	(0.00518)	(0.00627)	(0.00627)
Female household head (=1)	0.000708	0.000683	0.00165	0.00172
	(0.00510)	(0.00510)	(0.00528)	(0.00528)
Single (=1)	0.00308	0.00318	-0.00384	-0.00413
	(0.00701)	(0.00701)	(0.00857)	(0.00857)
Full-time worker (=1)	0.00380	0.00377	-0.00573*	-0.00566*
	(0.00254)	(0.00255)	(0.00338)	(0.00339)
Part-time worker (=1)	0.00516	0.00517	0.00354	0.00350
	(0.00402)	(0.00402)	(0.00522)	(0.00522)
Retired (=1)	-0.00302	-0.00307	-0.00409	-0.00394
	(0.00281)	(0.00281)	(0.00642)	(0.00642)
# of family members	0.00141	0.00143	0.00172	0.00166
	(0.00155)	(0.00155)	(0.00198)	(0.00198)
Male children (=1)	0.00331	0.00329	-0.00788*	-0.00781*
	(0.00217)	(0.00217)	(0.00408)	(0.00408)
# of non-coresident children	-0.00187	-0.00187	0.00276	0.00275
	(0.00125)	(0.00125)	(0.00269)	(0.00269)
# of coresident children	-0.00609***	-0.0061***	-0.00546*	-0.00538*
	(0.00212)	(0.00212)	(0.00297)	(0.00297)
No child (=1)	0.000638	0.000607	-0.00528	-0.00519
	(0.00480)	(0.00480)	(0.00705)	(0.00705)
Family decreased since 2004 (=1)	0.00920**	0.00908**	0.00688	0.00723
	(0.00439)	(0.00440)	(0.00563)	(0.00567)
City-size fixed effects	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Constant	0.118***	0.118***	-0.0567**	-0.0561**
	(0.0278)	(0.0278)	(0.0246)	(0.0246)
# of observations	10,756	10,756	10,756	10,756
R-squared	0.022	0.022	0.011	0.011
# of events	148	148	267	267

Note: Heteroskedasticity consistent standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1. Coefficients of missing categories are suppressed for the number of rooms, housing wealth, income, and financial wealth.

Appendix D: IV linaer probability model of mobility and renovation

To check the robustness of the 3SLS estimation in Section 4, we estimate the IV linear probability model of mobility and renovation by TSLS, without introducing the third equation for excess rooms. The first stage is to estimate bequest motives, and the second stage is to estimate the mobility and renovation probabilities by using the instrumented bequest motive.

D.1 Bequest motives (first-stage)

The first-stage equation is equation (1). The estimation result of this step is effectively identical for all IV models, except for small variations stemming from sample differences. Thus, we show the first-stage result for bequest motives only in columns 1 and 3 of Table 13 based on the TSLS estimation of the mobility model.

Households owning large residential lots (> 330 m^2) decreased bequest motives for real estate by 10.3 percentage points after the inheritance-tax change. Although the tax change also increased benefits for lots between 240 and 330 m^2, the coefficient is not statistically significant. These size thresholds are only relevant for inheritance tax because we separately control for lot size. Thus, this result provides evidence that the elasticity of bequest motives with respect to the effective tax rates is positive and significant, contributing to the discussion of the optimal inheritance tax rate (e.g., Piketty and Saez, 2013).

Table 13 TSLS Estimation of the Mobility Model

Dependent Variable	1. Bequest Motives for Real Estate	2. Moving	3. Bequest Motives for Real Estate	4. Moving
Variables	(1st stage)	(2nd stage)	(1st stage)	(2nd stage)
Bequest motive for real estate (t+1) (=1)		-0.0700**		-0.0721**
		(0.0287)		(0.0310)
Lot area, m2 (240,330] (=1)	0.000209		-0.00228	
	(0.0194)		(0.0195)	
Lot area, m2 (>330) (=1)	0.120***		0.112***	
	(0.0193)		(0.0208)	
Lot area, m2 (240,330] ×tax change (=1)	-0.00506		0.000557	
	(0.0278)		(0.0282)	
Lot area, m2 (>330)×tax change (=1)	-0.103***		-0.0815***	
	(0.0259)		(0.0308)	
After tax change (=1)	0.152***	0.00474	0.156***	0.00547
	(0.0153)	(0.00493)	(0.0156)	(0.00547)
Lot area, 100m2	0.00223*	-5.62e-05	0.00361**	4.49e-05
	(0.00126)	(0.000191)	(0.00178)	(0.000297)

Lot area×tax change (=1)			-0.00323	-0.000207
			(0.00258)	(0.000383)
# of rooms [4 or over] (=1)	0.0166	0.00154	0.0169	0.00158
	(0.0204)	(0.00591)	(0.0204)	(0.00591)
# of rooms: missing (=1)	-0.0681	-0.0146**	-0.0681	-0.0147**
	(0.0495)	(0.00697)	(0.0494)	(0.00711)
Condominium (=1)	-0.0905***	-0.000471	-0.0907***	-0.000675
	(0.0154)	(0.00532)	(0.0154)	(0.00553)
Ground lease (=1)	-0.0590**	-0.0121	-0.0589**	-0.0122
	(0.0291)	(0.00929)	(0.0291)	(0.00929)
Real housing equity, ln	0.0036***	0.00058*	0.0036***	0.00059*
	(0.00112)	(0.000337)	(0.00112)	(0.000343)
Real housing equity is missing (=1)	-0.00371	-0.000455	-0.00391	-0.000482
	(0.0141)	(0.00384)	(0.0141)	(0.00386)
Built after 1981 (=1)	0.0445***	-0.000307	0.0444***	-0.000221
	(0.0105)	(0.00330)	(0.0105)	(0.00333)
Age of household head(/10)	-0.119***	-0.0503***	-0.119***	-0.0506***
	(0.0238)	(0.00926)	(0.0238)	(0.00946)
Age of household head(squared, /100)	0.0139***	0.0043***	0.0140***	0.00434***
	(0.00233)	(0.000861)	(0.00233)	(0.000888)
Real income, ln	0.0178**	0.00524**	0.0177**	0.00528**
	(0.00726)	(0.00245)	(0.00726)	(0.00248)
Real income: missing (=1)	0.113**	0.0190	0.113**	0.0193
	(0.0524)	(0.0160)	(0.0524)	(0.0163)
Real financial wealth, ln	0.0185***	0.00110	0.0185***	0.00114
	(0.00176)	(0.000743)	(0.00176)	(0.000773)
Real financial wealth is missing (=1)	0.148***	0.00951	0.147***	0.00977
	(0.0328)	(0.00619)	(0.0328)	(0.00637)
College graduate (=1)	0.00469	0.00288	0.00472	0.00289
	(0.00997)	(0.00268)	(0.00997)	(0.00269)
Married (=1)	0.0341*	-0.00412	0.0343*	-0.00404
	(0.0177)	(0.00527)	(0.0177)	(0.00529)
Female household head (=1)	-0.0554***	-0.00309	-0.0551***	-0.00318
	(0.0143)	(0.00544)	(0.0143)	(0.00548)
Single (=1)	0.0555**	0.00708	0.0550**	0.00713
	(0.0251)	(0.00725)	(0.0251)	(0.00731)
Full-time worker (=1)	0.00753	0.00434*	0.00781	0.00437*
	(0.0101)	(0.00263)	(0.0101)	(0.00265)
Part-time worker (=1)	-0.0115	0.00442	-0.0115	0.00439
	(0.0136)	(0.00413)	(0.0136)	(0.00413)
Retired (=1)	-0.0141	-0.00384	-0.0138	-0.00383
	(0.0171)	(0.00307)	(0.0171)	(0.00309)
# of family members	-0.00170	0.00148	-0.00177	0.00147
	(0.00541)	(0.00159)	(0.00541)	(0.00159)
Male children (=1)	0.0141	0.00423*	0.0142	0.00427*
	(0.0119)	(0.00240)	(0.0119)	(0.00242)
# of non-coresident children	-0.0264***	-0.00360**	-0.0265***	-0.00366**
	(0.00639)	(0.00152)	(0.00639)	(0.00157)
# of coresident children	-0.0180**	-0.0076***	-0.0180**	-0.00763***
	(0.00910)	(0.00231)	(0.00910)	(0.00234)

No child (=1)	-0.299***	-0.0200**	-0.299***	-0.0206*
	(0.0186)	(0.0100)	(0.0186)	(0.0108)
Family decreased since 2004 (=1)	0.0563***	0.0129***	0.0567***	0.0131***
	(0.0147)	(0.00450)	(0.0147)	(0.00457)
Fixed effects(region and year)	Yes	Yes	Yes	Yes
Constant	0.323***	0.138***	0.322***	0.139***
	(0.0812)	(0.0302)	(0.0812)	(0.0306)
# of observations	10,756	10,756	10,756	10,756
R-squared	0.151	-0.050	0.151	-0.054
# of events		148		148
Kleibergen-Paap rk LM	40.36	[0.000]	29.85	[0.027]
Kleibergen-Paap Wald rk F	10.43		8.148	
Hansen J	3.850	[0.278]	4.345	[0.227]

Note: Cluster standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1. Coefficients of missing categories are suppressed for the number of rooms, housing wealth, income, and financial wealth.

Not surprisingly, children also impact bequest motives. Households with no children have a 29.9 percentage-point lower probability of having a bequest motive. An additional number of coresident children does not significantly impact the bequest-motive probability. Thus, if parents have at least one coresident child, they already have a high probability of bequeathing housing. In contrast, an additional non-coresident child decreases the bequest-motive probability by 2.64 percentage points; i.e., the bequest-motive probability is highest with only one child. Parents are willing to bequeath housing if they have only one child, regardless of the current coresidence status. However, parents lose their motives to bequeath housing when they have more than one child because an indivisible housing asset can become a source of disputes between multiple heirs. These results are consistent with altruistic and selfish bequest motives. The coefficient on male children is small and statistically insignificant. The primogeniture system may not be dominant in Japan any longer.

Age and several other household characteristics are also associated with bequest motives. The relationship between bequest motives and age is u-shaped with a minimum at 43 years old. Because bequest motives expressed by young household are noisy, we can conclude that the probability of having bequest motives increase at an increasing rate after their forties. Female household head has a 5.5 percentage-point smaller probability of bequest motives.

Housing characteristics also matter. Condominiums are associated with a smaller probability (-9.05 percentage points), whereas houses built after 1981 with significantly improved earthquake resistance standards are associated with a larger probability (4.4 percentage points). These results suggest that households with housing bequest motives tend to own less depreciating assets; detached housing (as opposed to condominiums) have a larger proportion of non-depreciating land, and newer structures with improved building standards depreciate less. Condominiums also require large capital expenditures later in a building life.

D.2 Mobility (second-stage)

Columns 2 and 4 of Table 13 show the second-stage result for moving decisions. The instrumented bequest motive has a statistically significant negative coefficient (-0.0700 in column two). Thus, bequest motives for real estate make a household less likely to move. When parents intend to bequeath a house, moving is often a suboptimal decision because of large transaction costs. A 6% brokerage fee is the highest among many developed countries. Thus, the low mobility of households is reasonable for households that have the intention to bequeath real estate. A consequence is more pronounced empty nests because low mobility is a cause of empty nests.

The IV estimate is larger in the absolute value than the OLS estimate (-0.00167 in Table 12) shown in Appendix C. This difference suggests positive reverse causality; i.e., those who decided to move are more likely to bequeath their houses. We validate our IV model by three tests. By the Kleibergen-Paap rk LM test (Kleibergen and Paap, 2006), we can reject the null hypothesis of under-identification. By the Kleibergen-Paap Wald rk F statistic, we reject the null of weak instruments at least ten percent based on the critical values (10% maximal IV relative bias, 10.27) provided by Stock and Yogo (2005). By Hansen's over-identification J test, we do not reject the null of orthogonality condition.

A no-child dummy is associated with 2 percentage-point lower mobility, whereas the male children variable is associated with 0.4 percentage-point higher mobility. Additional coresident children also decrease parents' mobility. These results suggest that some parents move to their non-coresident male child's location. Indeed, we do find that mobility increases in age after retirement age around 60 years old.[16] The estimated age profile of mobility exhibits a U-shape bottoming at 59 years old. However, the positive coefficient on the log real home equity (0.00058) suggests that negative home equity makes moving more difficult.

The u-shaped age profile also suggests that households do not tend to move before retirement. Working-age households may find it difficult to move when they have children. The negative coefficient on the number of coresident children(-0.0076) may be partly driven by the low mobility of working-age households.

Another trigger of moving other than retirement seems to be the loss of a family member. The coefficient is significantly positive (0.0129) on the "Family decreased since 2004" dummy. Households that experienced a family loss, such as death or divorce, are more likely to move their residence. Death of the family member is the most common reason accounting for 16 percent of mover households in the sample. This result, similar to that of Venti and Wise (2004), may imply

[16] The mandatory retirement age is 60 years old for 81% of firms according to Ministry of Health, Labour, and Welfare, General Survey on Working Conditions in 2016,

http://www.mhlw.go.jp/toukei/itiran/roudou/jikan/syurou/16/index.html (accessed on April 14, 2017)

that households move to smaller housing after a family loss. Our results are also consistent with the study by Bonnet et al. (2010), who find that widowhood significantly increases residential mobility in France, especially for those with older ages and with children.

Table 14 shows the result of a subsample analysis. The estimates are mostly statistically insignificant because of a lack of statistical power. When we exclude the households intending to make inter vivos transfers from the 2018 sample, the depressing effect of bequest motives on mobility increases by 7.25 percentage points (Column one). Although we do not have the same information for the earlier sample, this negative effect may be even larger if we exclude all inter vivos transfer intentions. Columns 2 and 3 show subsamples by the age of household heads. The negative effect seems to be larger for the working-age population although the result is not conclusive. Columns 4 and 5 show subsamples by region. The negative effect of bequest motives seems to be concentrated in rural regions without large metropolitan areas. However, standard errors are large to make a conclusion.

Table 14 Subsample Analysis of the Effect of Bequest Motives on Mobility

Variable	1.Excluding the intention of inter vivos in 2018 sample	2. The working-age household head (<60)	3. The elderly household head (>=60)	4. Metropolitan areas	5. Non-metropolitan areas
Bequest motive for real estate (t+1) (=1)	-0.0725**	-0.0920**	-0.0298	0.00696	-0.0851**
	(0.0288)	(0.0455)	(0.0246)	(0.0604)	(0.0367)
Lot area×tax change (=1)	No	No	No	No	No
Housing characteristics	Yes	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes	Yes
Fixed effects(region and year)	Yes	Yes	Yes	Yes	Yes
# of observations	10,104	6,861	3,895	5,937	4,819
R-squared	-0.058	-0.067	-0.015	0.023	-0.105
# of events	138	124	24	91	57
Kleibergen-Paap rk LM	40.30	27.13	18.21	15.97	21.86
	[0]	[0.034]	[0]	[0.586]	[0]
Kleibergen-Paap Wald rk F	10.43	7.099	4.477	4.330	5.499
Hansen J	3.336	6.262	0.793	1.802	8.875
	[0.343]	[0.1]	[0.851]	[0.614]	[0.031]

Note: The estimate is the coefficient β_4 on the instrumented bequest motives for real estate in the second-stage linear mobility regression. Regions with large metropolitan areas are Tokyo, Kanagawa, Chiba, Saitama, Aichi, Osaka, Kyoto, Hyogo, and Fukuoka. Heteroskedasticity consistent standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1. Coefficients of other variables are suppressed.

D.3 Renovation (second-stage)

Columns two and four in Table 15 show the second-stage estimation results for the renovation equation. The instrumented bequest motive has a statistically significant positive coefficient (0.154 in column 2). Thus, households with bequest motives are more likely to renovate their houses. For example, parents may renovate their house to add rooms when they expect to live with the child inheriting the house.

The IV estimate is larger than the OLS estimate (0.0109 in Table 12). The difference implies negative reverse causality: i.e., some households renovated their houses and lost motives to bequeath real estate. For example, parents may spend money on renovations to meet their needs and leave no bequest if they do not expect their heirs to return to their hometown (e.g., Baker and Kaul, 2002). Thus, the type and objective of renovations can be different for two directions of causality. We will distinguish three types of renovations (expansion, contraction, and no change in size) in the next subsection and gain additional insights.

The age profile is a concave function with a peak at 46 years old. It seems reasonable that elderly households are less likely to make renovations. Children also play a role in renovation decisions. A no-child dummy has a positive coefficient (0.0380), but the number of non-coresident children also has a positive coefficient (0.00640). This may imply that households without a child renovate houses for their needs. If a house is built after 1981 under the new building code, the probability of renovation is smaller by 0.88 percentage points.

Table 15 TSLS Estimation of the Renovation Model

Dependent Variable	1. Bequest Motives	2. Renovation	3. Bequest Motives	4. Renovation
Variables	(1st stage)	(2nd stage)	(1st stage)	(2nd stage)
Bequest motive for real estate (t+1) (=1)		0.154**		0.154**
		(0.0697)		(0.0769)
Lot area, m2 (240,330] (=1)	0.000209		-0.00228	
	(0.0194)		(0.0195)	
Lot area, m2 (>330) (=1)	0.120***		0.112***	
	(0.0193)		(0.0208)	
Lot area, m2 (240,330] ×tax change (=1)	-0.00506		0.000557	
	(0.0278)		(0.0282)	
Lot area, m2 (>330)×tax change (=1)	-0.103***		-0.0815***	
	(0.0259)		(0.0308)	
After tax change (=1)	0.152***	-0.0278**	0.156***	-0.0282**
	(0.0153)	(0.0111)	(0.0156)	(0.0127)
Lot area, 100m2	0.00223*	-0.000444	0.00361**	-0.000519
	(0.00126)	(0.000413)	(0.00178)	(0.000680)

Lot area×tax change (=1)			-0.00323	0.000182
			(0.00258)	(0.000761)
# of rooms [4 or over] (=1)	0.0166	0.000270	0.0169	0.000269
	(0.0204)	(0.00656)	(0.0204)	(0.00657)
# of rooms: missing (=1)	-0.0681	0.00949	-0.0681	0.00945
	(0.0495)	(0.0182)	(0.0494)	(0.0184)
Condominium (=1)	-0.0905***	0.00890	-0.0907***	0.00887
	(0.0154)	(0.00793)	(0.0154)	(0.00849)
Ground lease (=1)	-0.0590**	0.000821	-0.0589**	0.000771
	(0.0291)	(0.0103)	(0.0291)	(0.0104)
Real housing equity, ln	0.00359***	-0.000567	0.00358***	-0.000564
	(0.00112)	(0.000443)	(0.00112)	(0.000456)
Real housing equity is missing (=1)	-0.00371	0.000713	-0.00391	0.000735
	(0.0141)	(0.00501)	(0.0141)	(0.00501)
Built after 1981 (=1)	0.0445***	-0.00881*	0.0444***	-0.00878*
	(0.0105)	(0.00493)	(0.0105)	(0.00510)
Age of household head(/10)	-0.119***	0.0304***	-0.119***	0.0305**
	(0.0238)	(0.0112)	(0.0238)	(0.0119)
Age of household head(squared, /100)	0.0139***	-0.00308**	0.0140***	-0.00309**
	(0.00233)	(0.00122)	(0.00233)	(0.00131)
Real income, ln	0.0178**	0.00344	0.0177**	0.00346
	(0.00726)	(0.00306)	(0.00726)	(0.00313)
Real income: missing (=1)	0.113**	0.0115	0.113**	0.0115
	(0.0524)	(0.0210)	(0.0524)	(0.0215)
Real financial wealth, ln	0.0185***	-0.000702	0.0185***	-0.000691
	(0.00176)	(0.00145)	(0.00176)	(0.00156)
Real financial wealth is missing (=1)	0.148***	-0.00513	0.147***	-0.00502
	(0.0328)	(0.0164)	(0.0328)	(0.0170)
College graduate (=1)	0.00469	-0.00206	0.00472	-0.00206
	(0.00997)	(0.00376)	(0.00997)	(0.00376)
Married (=1)	0.0341*	-0.0116	0.0343*	-0.0116
	(0.0177)	(0.00711)	(0.0177)	(0.00722)
Female household head (=1)	-0.0554***	0.00962	-0.0551***	0.00958
	(0.0143)	(0.00704)	(0.0143)	(0.00723)
Single (=1)	0.0555**	-0.0122	0.0550**	-0.0122
	(0.0251)	(0.0102)	(0.0251)	(0.0103)
Full-time worker (=1)	0.00753	-0.00686*	0.00781	-0.00687*
	(0.0101)	(0.00370)	(0.0101)	(0.00373)
Part-time worker (=1)	-0.0115	0.00508	-0.0115	0.00508
	(0.0136)	(0.00561)	(0.0136)	(0.00560)
Retired (=1)	-0.0141	-0.00236	-0.0138	-0.00240
	(0.0171)	(0.00685)	(0.0171)	(0.00684)
# of family members	-0.00170	0.00157	-0.00177	0.00158
	(0.00541)	(0.00210)	(0.00541)	(0.00210)
Male children (=1)	0.0141	-0.00981**	0.0142	-0.00981**
	(0.0119)	(0.00451)	(0.0119)	(0.00452)
# of non-coresident children	-0.0264***	0.00640*	-0.0265***	0.00638*
	(0.00639)	(0.00333)	(0.00639)	(0.00344)
# of coresident children	-0.0180**	-0.00229	-0.0180**	-0.00232
	(0.00910)	(0.00366)	(0.00910)	(0.00372)

No child (=1)	-0.299***	0.0380*	-0.299***	0.0378
	(0.0186)	(0.0223)	(0.0186)	(0.0244)
Family decreased since 2004 (=1)	0.0563***	-0.000866	0.0567***	-0.000912
	(0.0147)	(0.00706)	(0.0147)	(0.00753)
Fixed effects(region and year)	0.0648***	-0.00857	0.0651***	-0.00856
	(0.0172)	(0.00740)	(0.0172)	(0.00757)
Fixed effects(region and year)	Yes	Yes	Yes	Yes
Constant	0.323***	-0.0994***	0.322***	-0.0993***
	(0.0812)	(0.0344)	(0.0812)	(0.0360)
# of observations	10,756	10,756	10,756	10,756
R-squared	0.151	-0.167	0.151	-0.166
# of events		267		267
Kleibergen-Paap rk LM	40.36	[0.000]	29.85	[0.020]
Stock_Yogo_Kleibergen-Paap Wald rk F	10.43		8.148	
Hansen J	3.999	[0.262]	4.362	[0.225]

Note: Heteroskedasticity consistent standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1. Coefficients of missing categories are suppressed for the number of rooms, housing wealth, income, and financial wealth.

Table 16 shows the result of a subsample analysis. The exclusion of inter vivos transfers in the 2018 sample significantly change the coefficient on bequest motives. However, decomposing the sample into the working-age and elderly household heads makes a significant impact. The effect of bequest motives is significantly larger for younger households (19.7 percentage points). Considering that 44 yeas old is the most active age for renovation activities, bequest motives can drive renovations, especially for households in their fifties. The effect of bequest motives is also larger in regions with large metropolitan areas. Because young households generally prefer large cities, parents will find it easier to live with a child's family if their house is located in a large city. Then, the major type of bequest-driven renovations can be an expansion to accommodate the inheriting child family in a large city.

Table 16 Subsample Analysis of the Effect of Bequest Motives on Renovation

Variables	1.Excluding the intention of inter vivos in 2018 sample	2. The working-age household head (<60)	3. The elderly household head (>=60)	4. Metropolitan areas	5. Non-metropolitan areas
Bequest motive for real estate (t+1) (=1)	0.150**	0.197**	0.0452	0.238*	0.0773
	(0.0695)	(0.0856)	(0.0978)	(0.125)	(0.0923)
Lot area×tax change (=1)	No	No	No	No	No
Housing characteristics	Yes	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes	Yes

Fixed effects(region and year)	Yes	Yes	Yes	Yes	Yes
# of observations	10,104	6,861	3,895	5,937	4,819
R-squared	-0.154	-0.335	0.007	-0.513	-0.010
# of events	250	143	124	128	139
Kleibergen-Paap rk LM	40.30	27.13	18.21	15.97	21.86
Stock_Yogo_Kleibergen-Paap Wald rk F	10.43	7.099	4.477	4.330	5.499
Hansen J	3.488	0.630	8.236	5.259	4.494
	[0.322]	[0.89]	[0.041]	[0.154]	[0.213]

Note: The estimate is the $\beta_{4'}$ coefficient on the instrumented bequest motive for housing in the second-stage linear renovation regression (equation (4')). Regions with large metropolitan areas are Tokyo, Kanagawa, Chiba, Saitama, Aichi, Osaka, Kyoto, Hyogo, and Fukuoka. Heteroskedasticity consistent standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1. Coefficients of other variables are suppressed.

D.4 Decomposing renovation types

We distinguish three types of renovations: capacity-increasing, capacity-maintaining, and capacity-decreasing renovations. We decompose the dummy variable for renovation into three: $y_{it} = y_{it}^{increasing} + y_{it}^{maintaining} + y_{it}^{decreasing}$. Then, we estimate equation (2) for each of the decomposed dependent variables. Thus, the estimated coefficients from the decomposed equations add up to the original coefficient for the aggregate renovation equation. Estimation results are summarized in Table 17 and the results based on subsample are shown in Table 18.

Column one of Table 17 demonstrates that the effect of bequest motives is largest for capacity-increasing renovations (9.2 percentage points). At the same time, bequest motives also drive working-age households' capacity-increasing renovations (9.1 percentage points in Table 18). By contrast, the effect of bequest motives is insignificant for capacity-decreasing renovations (Column three). Thus, the positive impact of bequest motives on renovation is mainly driven by parents' renovations to increase the number of rooms, possibly to accommodate a child's family to reside together. This result explains more excess rooms for renovators (see Figure 2) and confirms that parents renovate their house to add rooms when they expect to live with the child inheriting the house. However, working-age households' capacity-increasing renovations may result in long-term inefficiency to maintain excess rooms until they start to live with a child. This inefficiency is primarily caused by inheritance tax but exacerbated by imperfect financial markets where households need to arrange mortgage financing for renovations before retirement. The capacity-maintaining renovation by working-age households is likely seismic reinforcement and the repair of walls and roofs.

Table 17 Decomposed coefficients on the instrumented bequest motives for renovation

	1. Capacity-Increasing Renovations	2. Capacity-Maintaining Renovations	3. Capacity-Decreasing Renovations

Variables	(2nd stage)	(2nd stage)	(2nd stage)
Bequest motive for real estate (t+1) (=1)	0.0921**	0.0534	-0.0109
	(0.0402)	(0.0491)	(0.0244)
Lot area×tax change (=1)	No	No	No
Housing characteristics	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes
Fixed effects(region and year)	Yes	Yes	Yes
# of observations	10,754	10,754	10,754
R-squared	-0.320	-0.025	-0.000
# of events	54	153	58

Note: Coefficients are the estimated β_4 in equation (2). Clustered standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1.

Table 18 Subsample Analysis of the Effect of Bequest Motives on Renovation

	1.Excluding the intention of inter vivos in 2018 sample	2.Working population (age of the household head < 60)	3.Elderly population (age of the household head>= 60)	4.Metropolitan areas	5.Non-Metropolitan areas
(A)Capacity-Increasing Renovations					
Housing bequest motive (t+1) (=1)	0.0879**	0.0912**	0.0898	0.0729	0.0417
	(0.0393)	(0.0432)	(0.0627)	(0.0599)	(0.0538)
# of observations	9,989	6,859	3,894	5,936	4,817
# of events	50	26	28	19	35
(B)Capacity-Maintaining Renovations					
Housing bequest motive (t+1) (=1)	0.0534	0.0932	-0.0512	0.144	0.0235
	(0.0483)	(0.0654)	(0.0665)	(0.0902)	(0.0686)
# of observations	9,989	6,859	3,894	5,936	4,817
# of events	142	85	68	82	71
(C)Capacity-Decreasing Renovations					
Housing bequest motive (t+1) (=1)	-0.0112	0.00170	-0.0167	-0.0188	-0.000729
	(0.0238)	(0.0296)	(0.0370)	(0.0389)	(0.0340)

# of observations	9,989	6,859	3,894	5,936	4,817
# of events	56	31	27	26	32

Note: Coefficients are the estimated β_4 in equation (2). Clustered standard errors over households are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1.

Appendix E: Placebo tests

The main identifying assumption in such empirical analysis is that the owner of housing with larger lot size and other owners would have witnessed similar bequest motive trends in the absence of change of the inheritance tax code. Table 19 shows the estimation results of beeuest motive models with false tax change in 2008. From these models we find out that no significant coefficients of the interaction terms of lot size dummies and False tax change dummies. Thus we conclude that parallel trand assuptions are satisfied, which are necessary conditions to identify the change of the bequest motives due to the tax changes in 2015.

Table 19 Placebo tests: False tax change in 2008

Dependent Variable	1. Bequest Motives for Real Estate	2. Bequest Motives for Real Estate	3. Bequest Motives for Real Estate	4. Bequest Motives for Real Estate	5. Bequest Motives for Real Estate
Variables	(1st stage for Excess room model)	(1st stage for mobility, LPM)	(IV Probit)	(1st stage for renovation, LPM)	(IV Probit)
Lot area, m2 (240,330] (=1)	0.00261	-0.00617	-0.000744	0.000414	0.0165
Lot area, m2 (>330) (=1)	0.116***	0.0991***	0.279***	0.116***	0.328***
Falsified Tax Change	0.0203	0.0177	0.0569	0.0185	0.0549
Lot (240,330] x False Change	-0.0216	-0.0193	-0.0768	-0.0194	-0.0703
Lot >330 x False Change	-0.0141	-0.00768	-0.0211	-0.0150	-0.0348
Lot area, 100m2	3.28e-05*	0.00327*	0.0102*	0.00320*	0.00947*
Covariates	Yes	Yes	Yes	Yes	Yes
Fixed effects(region and year)	Yes	Yes	Yes	Yes	Yes
# of observations	5,659	5,546	5,546	5,615	5,615

Note: Clustered standard errors over households for models are calculated in parenthesis. Significant level: *** p<0.01, ** p<0.05, * p<0.1.

Appendix F: IV Probit model

As a robustness check, we estimate the IV Probit model considering the non-linear relationship between bequest motives and the probability of moving and renovation decisions. We simultaneously estimate the following bequest and outcome equations by maximum likelihood:

$$B_{it}^{H} = 1\left[\boldsymbol{z}_{it-1}'\boldsymbol{\theta}_{\mathbf{1}}' + \boldsymbol{x}_{it-1}'\boldsymbol{\delta}_{\mathbf{1}}' + J_j + T_t + \boldsymbol{\varepsilon}_{\mathbf{1}}'_{it} > 0\right]$$

$$y_{it} = 1\left[\beta_2' B_{it}^{H} + \boldsymbol{x}_{it-1}'\boldsymbol{\delta}_{\mathbf{2}}' + J_j + T_t + \boldsymbol{\varepsilon}_{\mathbf{2}}'_{it} > 0\right]$$

A benefit of this model is that identification may not require an exclusion restriction for an instrumental vector unlike for a linear model because the model is identified by the nonlinearity (Wooldridge, 2010). Thus, we can have a consistent estimate even if instruments are contaminated (i.e., if an exclusion restriction is not satisfied).

F.1 Mobility

Table 20 shows the IV Probit estimation result and the average partial effect (APE) for interpretations. The instrumented bequest motive for real estate has a statistically significant negative coefficient. The partial effect of bequest motive on mobility at average is -9.08 percentage points. Other statistically significant coefficients are also large in magnitude than in the linear model as suggested by literature that Probit estimates tend to show larger marginal effects on probability than the linear model (Wooldridge, 2010, Chapter 15). For example, the APE is -3.59 percentage points for a no-child dummy and 2.27 percentage points for a family-decrease dummy.

Table 20 IV Probit Model for Mobiltiy

Dependent Variable	1. Bequest Motives for Real Estate	2. Moving		3. Bequest Motives for Real Estate	4. Moving	
Variables	(1st stage)	(2nd stage)	(APE)	(1st stage)	(2nd stage)	(APE)
Bequest motive for real estate (t+1) (=1)		-1.214***	-0.0908*		-1.193***	-0.0871*
		(0.266)	(0.0465)		(0.274)	(0.0464)
Lot area, m2 (240,330] (=1)	0.00924			-7.12e-05		
	(0.0574)			(0.0578)		
Lot area, m2 (>330) (=1)	0.345***			0.316***		
	(0.0564)			(0.0610)		
Lot area, m2 (240,330] ×tax change (=1)	-0.0460			-0.0258		
	(0.0801)			(0.0815)		
Lot area, m2 (>330)×tax change (=1)	-0.307***			-0.238***		
	(0.0742)			(0.0916)		
After tax change (=1)	0.424***	0.0336	0.00252	0.433***	-0.0131	0.00252

	(0.0439)	(0.116)	(0.00903)	(0.0450)	(0.130)	(0.00896)
Lot area, 100m2	0.00727*	-0.0213	-0.00159	0.0114**	-0.0359	-0.00180
	(0.00414)	(0.0176)	(0.00130)	(0.00551)	(0.0250)	(0.00124)
Lot area×tax change (=1)				-0.00967	0.0263	
				(0.00828)	(0.0293)	
# of rooms [4 or over] (=1)	0.0384	0.0433	0.00324	0.0393	0.0423	0.00309
	(0.0620)	(0.135)	(0.0101)	(0.0621)	(0.136)	(0.00993)
# of rooms: missing (=1)	-0.208	-3.326	-0.249	-0.209	-3.139	-0.229
	(0.148)	(291.4)	(21.80)	(0.148)	(167.1)	(12.20)
Condominium (=1)	-0.265***	0.0187	0.00140	-0.267***	0.0149	0.00109
	(0.0464)	(0.102)	(0.00750)	(0.0464)	(0.103)	(0.00740)
Ground lease (=1)	-0.240**	-0.263	-0.0197	-0.239**	-0.257	-0.0188
	(0.103)	(0.208)	(0.0168)	(0.103)	(0.210)	(0.0165)
Real housing equity, ln	0.00947***	0.00902	0.000675	0.00946***	0.00927	0.000677
	(0.00322)	(0.00730)	(0.000589)	(0.00322)	(0.00734)	(0.000582)
Real housing equity is missing (=1)	-0.0218	-0.00493	-0.000369	-0.0224	-0.00432	-0.000316
	(0.0418)	(0.0954)	(0.00714)	(0.0418)	(0.0960)	(0.00701)
Built after 1981 (=1)	0.135***	-0.0745	-0.00558	0.134***	-0.0771	-0.00563
	(0.0313)	(0.0743)	(0.00532)	(0.0313)	(0.0748)	(0.00522)
Age of household head(/10)	-0.285***	-0.644***	-0.00970***	-0.287***	-0.643***	-0.00965***
	(0.0781)	(0.166)	(0.00287)	(0.0781)	(0.167)	(0.00283)
Age of household head(squared, /100)	0.0354***	0.0531***		0.0355***	0.0528***	
	(0.00746)	(0.0170)		(0.00746)	(0.0171)	
Real income, ln	0.0445**	0.107**	0.00801*	0.0443**	0.110**	0.00801*
	(0.0221)	(0.0534)	(0.00453)	(0.0221)	(0.0539)	(0.00451)
Real income: missing (=1)	0.271*	0.280	0.0210	0.272*	0.292	0.0214
	(0.162)	(0.419)	(0.0321)	(0.162)	(0.422)	(0.0316)
Real financial wealth, ln	0.0553***	0.0168	0.00126	0.0552***	0.0166	0.00121
	(0.00524)	(0.0124)	(0.00109)	(0.00524)	(0.0125)	(0.00108)
Real financial wealth is missing (=1)	0.450***	0.00515	0.000386	0.450***	-4.69e-05	-3.42e-06
	(0.0930)	(0.323)	(0.0242)	(0.0931)	(0.325)	(0.0238)
College graduate (=1)	0.00433	0.0570	0.00426	0.00462	0.0580	0.00424
	(0.0291)	(0.0671)	(0.00518)	(0.0291)	(0.0675)	(0.00510)
Married (=1)	0.117**	-0.0489	-0.00366	0.118**	-0.0487	-0.00355
	(0.0563)	(0.122)	(0.00902)	(0.0563)	(0.123)	(0.00886)
Female household head (=1)	-0.191***	-0.0803	-0.00601	-0.190***	-0.0778	-0.00568
	(0.0488)	(0.0937)	(0.00753)	(0.0488)	(0.0943)	(0.00740)
Single (=1)	0.183**	0.269	0.0201	0.182**	0.274	0.0200
	(0.0763)	(0.168)	(0.0141)	(0.0763)	(0.169)	(0.0139)
Full-time worker (=1)	0.0239	0.101	0.00753	0.0248	0.102	0.00743
	(0.0295)	(0.0687)	(0.00542)	(0.0295)	(0.0691)	(0.00534)
Part-time worker (=1)	-0.0431	0.0814	0.00609	-0.0433	0.0836	0.00611
	(0.0424)	(0.0923)	(0.00689)	(0.0424)	(0.0928)	(0.00677)
Retired (=1)	-0.0344	-0.218	-0.0163	-0.0340	-0.220	-0.0161
	(0.0485)	(0.164)	(0.0132)	(0.0485)	(0.165)	(0.0130)
# of family members	-0.0144	0.0186	0.00139	-0.0145	0.0202	0.00148
	(0.0168)	(0.0366)	(0.00274)	(0.0168)	(0.0368)	(0.00269)
Male children (=1)	0.0347	0.130	0.00970	0.0345	0.129	0.00942

	(0.0320)	(0.0925)	(0.00709)	(0.0320)	(0.0929)	(0.00698)
# of non-coresident children	-0.0760***	-0.147***	-0.0110**	-0.0761***	-0.148***	-0.0108**
	(0.0178)	(0.0563)	(0.00524)	(0.0178)	(0.0567)	(0.00521)
# of coresident children	-0.0266	-0.173**	-0.0130**	-0.0266	-0.177**	-0.0129**
	(0.0262)	(0.0687)	(0.00599)	(0.0262)	(0.0693)	(0.00596)
No child (=1)	-0.886***	-0.479***	-0.0359*	-0.886***	-0.476***	-0.0348*
	(0.0555)	(0.162)	(0.0198)	(0.0555)	(0.164)	(0.0197)
Family decreased since 2004 (=1)	0.176***	0.304***	0.0227**	0.178***	0.301***	0.0220**
	(0.0439)	(0.0934)	(0.00957)	(0.0439)	(0.0939)	(0.00952)
Fixed effects(region and year)	Yes	Yes		Yes	Yes	
ρ	0.803***			0.787***		
	(0.220)			(0.225)		
Constant	-0.624**	-0.447		-0.624**	-0.453	
	(0.250)	(0.553)		(0.250)	(0.557)	
# of observations	10,756	10,756	10,756	10,756	10,756	10,756
Log-likelihood	-7130.9912			-7129.8744		
ρ	0.666		[0.000]	0.657		[0.000]

Note: Standard errors of APE are calculated by the delta method. Significant level: *** p<0.01, ** p<0.05, * p<0.1. Coefficients of missing categories are suppressed for the number of rooms, housing wealth, income, and financial wealth.

F.2 Renovation

By the IV Probit model in Table 21, the estimated average partial effect of bequest motives is more moderate (4.1 percentage points) than the effect estimated by the IV linear model. Considering the advantage of the IV probit model when an exclusion restriction is imperfect, we regard the probit estimate as our main result. Other coefficients are mostly consistent with those in the linear model.

Table 21 IV Probit Model for Renovation

Dependent Variable	1. Bequest Motives	2. Renovation		3. Bequest Motives	4. Renovation	
Variables	(1st stage)	(2nd stage)	APE	(1st stage)	(2nd stage)	APE
Bequest motive for real estate (t+1) (=1)		0.629**	0.0410		0.599*	0.0385
		(0.307)	(0.0273)		(0.321)	(0.0275)
Lot area, m2 (240,330] (=1)	0.0110			0.00297		
	(0.0584)			(0.0589)		
Lot area, m2 (>330) (=1)	0.348***			0.321***		
	(0.0569)			(0.0616)		
Lot area, m2 (240,330] ×tax change (=1)	-0.0287			-0.0116		

	(0.0810)			(0.0823)		
Lot area, m2 (>330)×tax change (=1)	-0.304***			-0.239***		
	(0.0747)			(0.0922)		
After tax change (=1)	0.423***	-0.202**	-0.0131*	0.434***	-0.179*	-0.0129*
	(0.0440)	(0.0923)	(0.00725)	(0.0450)	(0.101)	(0.00720)
Lot area, 100m2	0.00696*	0.00166	0.000109	0.0110**	0.00365	2.97e-05
	(0.00415)	(0.00642)	(0.000413)	(0.00552)	(0.00733)	(0.000456)
Lot area×tax change (=1)				-0.00955	-0.00795	
				(0.00829)	(0.0147)	
# of rooms [4 or over] (=1)	0.0368	0.0355	0.00232	0.0378	0.0376	0.00241
	(0.0620)	(0.141)	(0.00917)	(0.0621)	(0.141)	(0.00904)
# of rooms: missing (=1)	-0.208	0.0757	0.00494	-0.208	0.0750	0.00481
	(0.148)	(0.316)	(0.0207)	(0.148)	(0.317)	(0.0204)
Condominium (=1)	-0.263***	-0.0570	-0.00372	-0.264***	-0.0625	-0.00401
	(0.0465)	(0.110)	(0.00703)	(0.0465)	(0.111)	(0.00695)
Ground lease (=1)	-0.240**	-0.158	-0.0103	-0.239**	-0.158	-0.0102
	(0.103)	(0.244)	(0.0159)	(0.103)	(0.245)	(0.0157)
Real housing equity, ln	0.0095***	-0.0003	-2.03e-05	0.0095***	-0.00024	-1.55e-05
	(0.00322)	(0.00759)	(0.000495)	(0.00322)	(0.00761)	(0.000489)
Real housing equity is missing (=1)	-0.0197	0.0342	0.00223	-0.0205	0.0340	0.00218
	(0.0419)	(0.0891)	(0.00582)	(0.0419)	(0.0893)	(0.00574)
Built after 1981 (=1)	0.135***	-0.0573	-0.00374	0.134***	-0.0570	-0.00366
	(0.0314)	(0.0613)	(0.00416)	(0.0314)	(0.0615)	(0.00411)
Age of household head(/10)	-0.284***	0.337**	0.000528	-0.285***	0.331**	0.000609
	(0.0781)	(0.163)	(0.00214)	(0.0781)	(0.164)	(0.00212)
Age of household head(squared, /100)	0.0353***	-0.0294*		0.0354***	-0.0286*	
	(0.00746)	(0.0156)		(0.00746)	(0.0157)	
Real income, ln	0.0451**	0.105**	0.00683**	0.0451**	0.106**	0.00682**
	(0.0222)	(0.0483)	(0.00312)	(0.0222)	(0.0485)	(0.00308)
Real income: missing (=1)	0.274*	0.434	0.0283	0.275*	0.444	0.0285
	(0.162)	(0.361)	(0.0231)	(0.163)	(0.362)	(0.0228)
Real financial wealth, ln	0.0546***	0.0339**	0.00221***	0.0545***	0.0345**	0.00221***
	(0.00525)	(0.0137)	(0.000797)	(0.00525)	(0.0139)	(0.000786)
Real financial wealth is missing (=1)	0.450***	0.312	0.0204	0.450***	0.316	0.0203
	(0.0933)	(0.197)	(0.0125)	(0.0934)	(0.198)	(0.0124)
College graduate (=1)	0.00592	-0.0144	-0.000940	0.00619	-0.0139	-0.000891
	(0.0291)	(0.0593)	(0.00388)	(0.0291)	(0.0595)	(0.00383)
Married (=1)	0.115**	-0.145	-0.00944	0.116**	-0.144	-0.00923
	(0.0563)	(0.109)	(0.00739)	(0.0563)	(0.109)	(0.00730)
Female household head (=1)	-0.192***	0.0568	0.00370	-0.190***	0.0563	0.00361
	(0.0488)	(0.0925)	(0.00616)	(0.0488)	(0.0927)	(0.00608)
Single (=1)	0.183**	-0.106	-0.00688	0.182**	-0.107	-0.00685
	(0.0765)	(0.151)	(0.0101)	(0.0765)	(0.152)	(0.00994)
Full-time worker (=1)	0.0227	-0.112*	-0.00727*	0.0235	-0.111*	-0.00713*
	(0.0296)	(0.0621)	(0.00425)	(0.0296)	(0.0622)	(0.00419)
Part-time worker (=1)	-0.0439	0.0742	0.00484	-0.0440	0.0738	0.00473
	(0.0424)	(0.0793)	(0.00524)	(0.0424)	(0.0795)	(0.00517)
Retired (=1)	-0.0370	-0.0610	-0.00398	-0.0365	-0.0597	-0.00383
	(0.0485)	(0.0927)	(0.00605)	(0.0485)	(0.0929)	(0.00597)

# of family members	-0.0129	0.0359	0.00234	-0.0131	0.0360	0.00231
	(0.0168)	(0.0323)	(0.00213)	(0.0168)	(0.0324)	(0.00210)
Male children (=1)	0.0331	-0.123*	-0.00801*	0.0331	-0.122*	-0.00785*
	(0.0320)	(0.0651)	(0.00450)	(0.0320)	(0.0652)	(0.00445)
# of non-coresident children	-0.0764***	0.0462	0.00301	-0.0764***	0.0456	0.00293
	(0.0178)	(0.0345)	(0.00241)	(0.0178)	(0.0346)	(0.00238)
# of coresident children	-0.0289	-0.109*	-0.00712*	-0.0287	-0.110*	-0.00705*
	(0.0262)	(0.0566)	(0.00367)	(0.0262)	(0.0568)	(0.00362)
No child (=1)	-0.887***	0.0526	0.00343	-0.886***	0.0454	0.00291
	(0.0555)	(0.139)	(0.00944)	(0.0555)	(0.142)	(0.00943)
Family decreased since 2004 (=1)	0.178***	0.0903	0.00589	0.179***	0.0953	0.00611
	(0.0440)	(0.0847)	(0.00536)	(0.0440)	(0.0855)	(0.00530)
Fixed effects(region and year)	Yes	Yes		Yes	Yes	
Constant	-0.631**	-3.713***		-0.631**	-3.715***	
	(0.250)	(0.540)		(0.250)	(0.542)	
# of observations	10,756	10,756	10,756	10,756	10,756	10,756
Log likelihood	-7633.2191			-7632.3613		
ρ	-0.2621825		[0.1653]	-0.2454533		[0.2136]

Note: Standard errors of APEs are calculated by the delta method. Significant level: *** p<0.01, ** p<0.05, * p<0.1. Coefficients of missing categories are suppressed for the number of rooms, housing wealth, income and financial wealth.

Appendix G: Additional properties of underutilized rooms

The following figure shows the difference between renovators and non-renovators. Figure 5 depictes the difference of estimated underutilized rooms against quantiles of housin prices. From these figures, we can see that the estimated underutilized rooms is more pronounced when house values are larger. This variation is also consistent with our finding that housing bequest motives affect renovation decisions. By contrast, Figure 6 and Figure 7 show the differences of estimated underutilized rooms against quintiles of real household income and real financial wealth, respectively. From these figures, we can see that the difference is not positively correlated with income or general wealth.

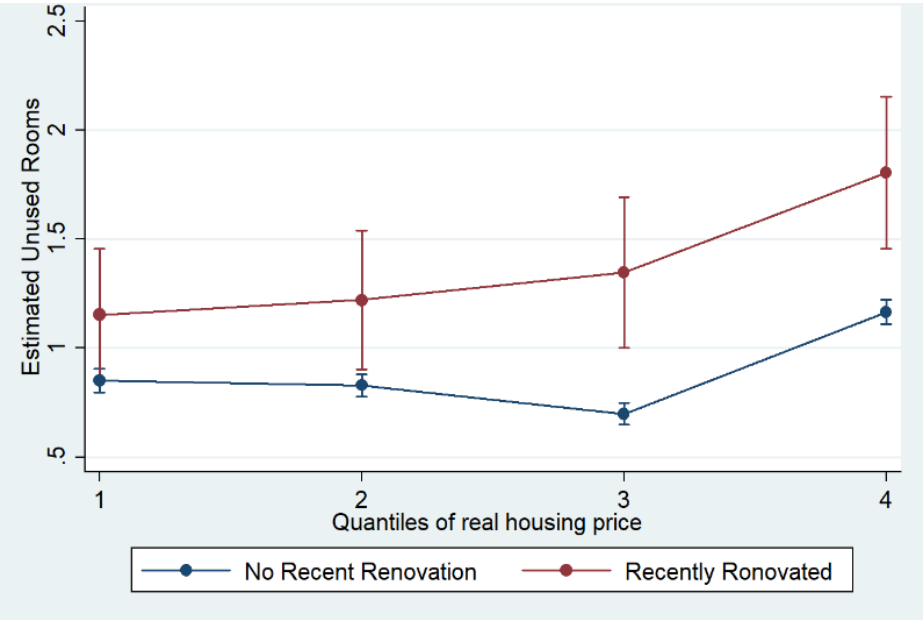

Figure 5 Estimated underutilized rooms by real housing price

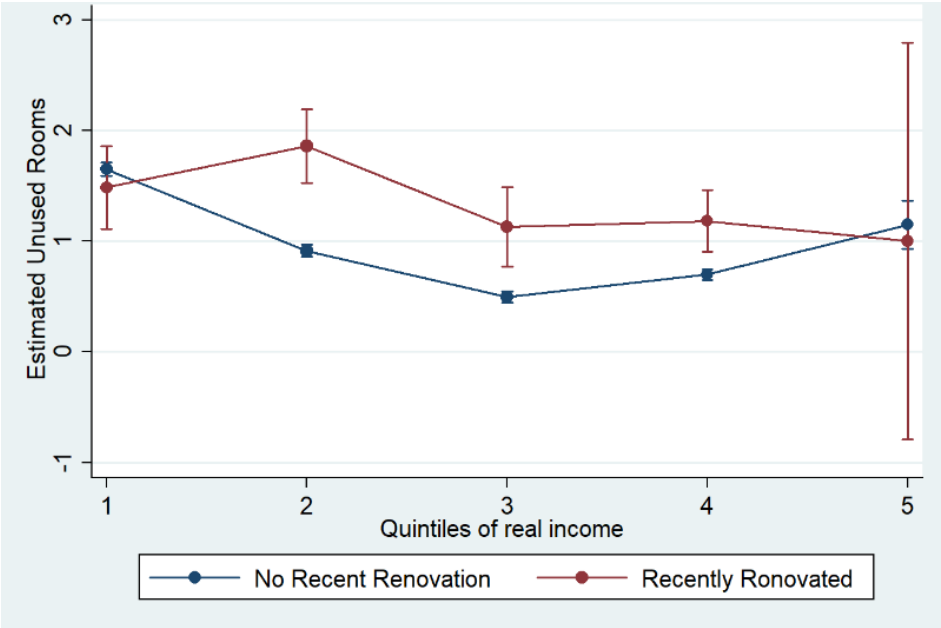

Figure 6 Estimated underutilized rooms by real income

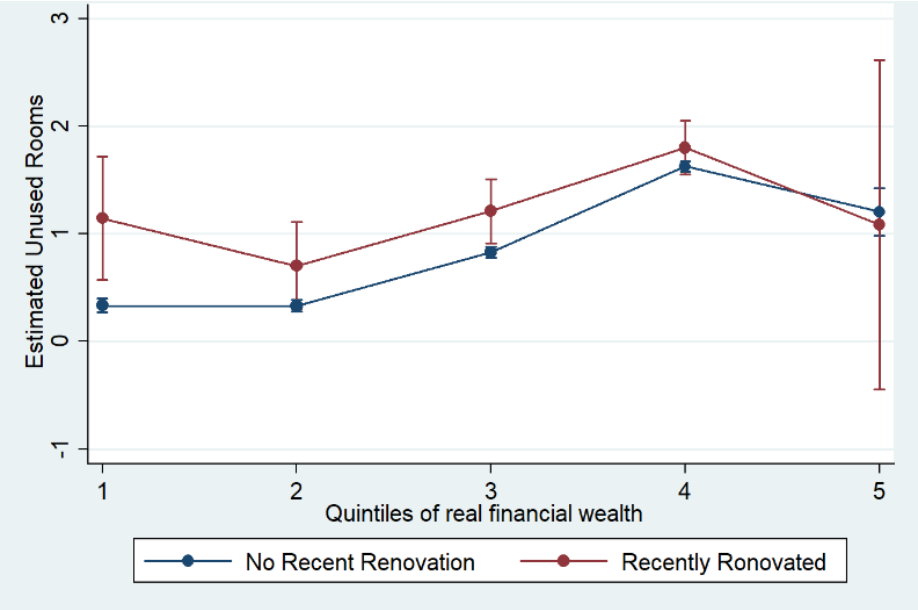

Figure 7 Estimated underutilized rooms by real financial wealth